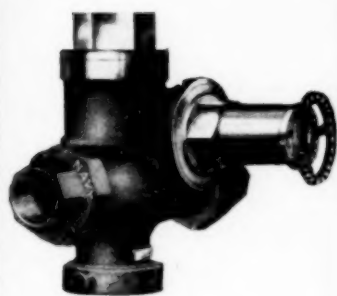
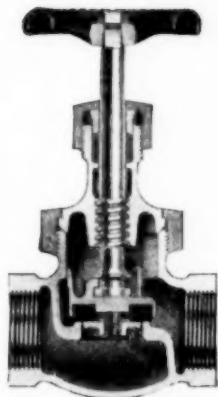


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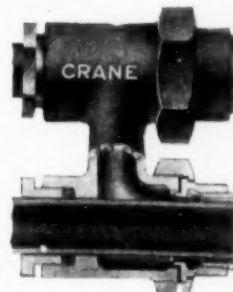
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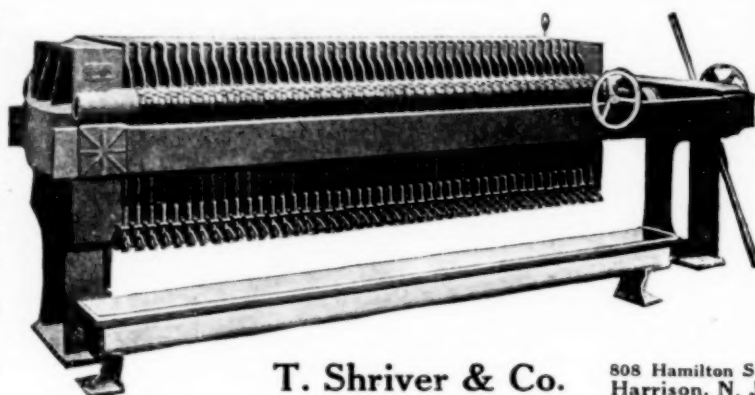
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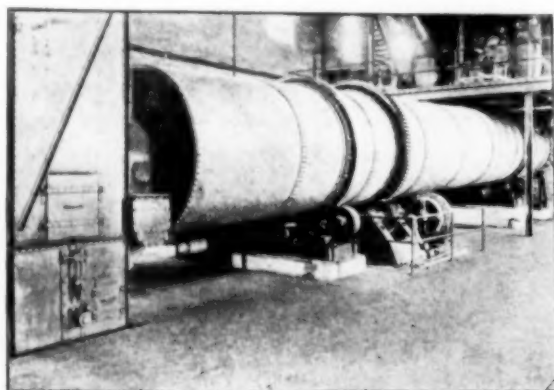
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Number 18

Considerations on Dye Licensing

ACCORDING to our British contemporary *The Chemical Age*, the question of regulating dye imports in that country has had the benefit of wide discussion, and it resolves itself into four possible methods from which to choose. These are: First, free imports—which means no restriction, and this is generally regarded as inadmissible despite free trade traditions. National safety requires that there be a well-developed organic chemical industry at home. Secondly, protection by tariff is not feasible owing to the low value of marks, and because the German dye producers are past masters in getting around tariff restrictions. Thirdly, subsidy, which has been tried but has been discontinued. This always brings trouble in a democratic government. The fourth is the prohibition of dye imports except under license. This method will probably be adopted.

Now the calico printers have a very strong organization in England, and they speak with authority for their whole trade. They also appear to be in accord—which is more than we can say of American manufacturers. They would of course prefer free trade, so far as their own business is concerned, but they have declared themselves ready to accept the license system provided four stipulations which they make are agreed to. These are:

That the licensing committee shall consist of practical men with technical knowledge.

The color-consuming trade shall be consulted as to the licensing machinery employed.

The onus of proof as to the suitability of the British color to meet the needs of the trade must lie on the color maker and not on the color consumer.

The licensing system must be limited to a definite period.

What our British cousins mean by "a practical man with technical knowledge" would seem to be expressed in the words themselves, but over here the expression would need definition of the subject of technical training. Years of adherence to the rule of thumb in many industries have almost demanded of the practical man that he shall not even be familiar with the theory of his profession. We should be very much concerned if a commission to pass on the need of imports of dyes were made up of practical dyers of the type that has flourished for over a generation in a large number of dye houses and textile mills. They don't know enough of chemistry, both theoretical and applied, or of the materials to be considered, and besides this they have itching palms. The idea is sound to require men of technical training and experience, but it is equally important that they be men of character and under-

standing who are appointed to the posts. The records of more than a few practical dyers would disqualify them.

The second requirement that the color-consuming trade be consulted as to the licensing machinery employed may also work well in England, but here again we see trouble in America. The vindictive action during the last Congress of Senator MOSES of New Hampshire, for instance, who is likely to be returned to the Senate this year, in killing the dye bill with the jawbones of Senators THOMAS and KENYON, is significant. The influence of local corporations on some of our representatives in the House and in the Senate is unfortunate, but we must count on it. The present Mayor of Philadelphia, J. HAMPDEN MOORE, is another example who, while in Congress, was blinded to the country's welfare by the interests of one or two local mills. What such men think is not important, but the influence of German agents in the mill in their respective districts and the resolution of their directors to kill any American industry that stands in the way of cheapest dyes for their use are serious hazards. The act of CLAUDE KITCHIN while chairman of the Ways and Means Committee in Congress in discriminating against indigo and most vat dyes is another example. What Mr. KITCHIN thought was not important, but what the owners of some North Carolina mills thought was reflected in his deeds.

That the system of license be limited in the period of its duration is also fair. No industry is entitled to such permanent preference. The trouble is, however, that the duration of research cannot be predicted. We are still short of anthracene in the United States, and of vat dyes made from it, and while it would be unfair to give this situation an indefinite warrant for continuance, it would be doubly unfortunate to cut off protection too soon. The only hope seems to be in the synthesis of anthraquinone from some other intermediate than anthracene, because after the anthracene is extracted from tar the pitch seems unavailable for roofing or road making. The briquetting industry in which such pitch is available is not developed here.

The users of dyes are entitled to a voice in the matter. They are the interested parties, and they have the right, from the services they render, to very earnest consideration. But some users of dyes are in sore need to see a greater light. There is no reason at all why a large mill in New Hampshire should destroy the chance of the country to enjoy military protection, as one did in the last session of Congress. We are in full accord with the idea that the onus of proof of the need—or the lack of need—of a dye should rest on the color makers, but there must be provided a tribunal at once competent and impartial to render judgment. It would

be no less than a farce if the commission were to consist of agents of recalcitrant mills who are resolved to buy German dyes no matter what else happens, whether these men be in the Senate or in the House or otherwise appointed.

The textile industry in this country is a great institution. The point we want to make is that among them there are some who are too much interested in their own profits to consider national welfare. They should be set apart in a class by themselves, and participate only in separate hearings.

Extent and Duration Of "Readjustment"

A GREAT guessing contest is on—how far the "readjustment" in markets and in industries generally will extend, and how much time the operation will require. Predictions are numerous but usually lack definiteness. Then there are differences in viewpoint, or in the precise thing about which the prediction is made. Thus, in the iron and steel industry there are predictions that price declines will be over and buying will begin to revive by next April, while there are bankers who predict that the readjustment will require two or three years. The predictions do not refer to the same thing. The prediction in the steel trade is simply as to the next "buying movement" in steel products, while the banker is thinking of when it will be safe and profitable to make investments of the most permanent character, those that must depend on the long future for a return of the capital, with suitable earnings meanwhile. One case involves commodities that are to be bought and liquidated or consumed, the other involves property that must continue indefinitely to be worth its purchase price.

The comparison suggests that there are two distinct things. One, pertaining to commodity markets, is merely a market movement. The other, pertaining to the whole complicated relationship between property values, values of securities, interest rates and the value of the dollar generally, is in its essence a readjustment from war-time conditions and the strained conditions that curiously sprang into being upon the war's ending. By a free interpretation of the word "readjustment" it could be used to connote what occurs in a commodity market when that market rises or falls, but before the war the word was not commonly used in connection with market movements, and the meaning commonly attached to the word since the signing of the Armistice, translated into the vernacular, is in substance "getting over the war."

If we can "get over the war" in three years' more time, making five years in all, we shall do well enough. Meanwhile commodity markets will have their declines and advances at recurrent intervals according to the circumstances involved in the particular commodity, for some commodities have different wave lengths of fluctuation from others.

There is no reason at this time for anyone to fear readjustment, or to look upon the development as something that should not be welcomed. We must get over the war some time, and if the operation is delayed troubles will be piled up. That is what occurred after our Civil War. Either because our currency was fictitious, not being based on gold or any other definite thing, or because we were young, thoughtless and extravagant, we had a period of eight years of infla-

tion and reckless expansion that ended in a grand collapse, requiring five years of severe industrial depression to correct. That depression was the "readjustment" after the Civil War. We need have no fears regarding a readjustment after the World War that comes at this time, for we have builded too little rather than too much. We want industry and finance to get on a basis such as will make building wise, profitable and safe. The only danger is of the readjustment not being complete.

Already some far-sighted men have become hopeful that we are about to enter a new age in the history of American industry, an age that will be characterized by the absence of the industrial depressions that have marked our past and have been largely peculiar to the United States. The idea is that business will be conducted so conservatively that severe depressions will not be invited. These recurrent spells are natural to a young and growing country, so large a proportion of the "jobs" being in construction work that if building receives a chill the men thrown out of employment in the building trades cannot make work for themselves elsewhere.

Speculations on Sub-Atomic Energy

WE HAVE no less an authority than Professor A. S. EDDINGTON for the opinion that the source of a star's heat cannot be explained by the energy of gravitational attraction, but that it is rather to be accounted for by sub-atomic energy set free within the star. It is recorded in his address before the British Association for the Advancement of Science and published in the October number of *The Scientific Monthly*. Now the development of energy and the use of power from changes in state of sub-atomic particles is the substance of our hope for the continuance and development of civilization after the coal is gone, and it is also a proper basis for our fears for the future if the progress of research is too rapid.

Professor SODDY says, in effect, in "Science and Life" that if we could force the disintegration of radioactive substances so as to control the velocity of disintegration, we should obtain as much energy from one pound of such material as would be developed by burning 150 tons of coal, or that the same pound of material could be made to do the work of 150 tons of dynamite. We doubt if the world is quite ready for such efficiency as yet. Indeed, we offer this as an argument why we need development in the art of living and in human understanding and in character along with the study of science.

The same authority (SODDY) informs us that "Small as is the proportion of uranium and thorium in the rocks of the earth, the energy they evoke is estimated to be far more than the earth loses to outer space if the surface composition of the rocks is maintained uniformly throughout the core. Unless this is not the case, or unless the energy they evoke is being utilized in unknown ways, the conclusion follows that the interior of the globe must be getting hotter instead of colder. The uncomfortable prediction of the ultimate destruction of the world by fire is now at least as possible as the former fate pictured by science that the world must be steadily cooling and that it was only a matter of time before it became lifeless and dead."

The sub-atomic changes which Professor EDDINGTON

has in mind are not wholly atomic disintegrations. Normally we should say that energy is required for the synthesis of atoms, and is given off on their disintegration. But Professor EDDINGTON follows F. W. ASTON in his conclusion that all elements are constituted out of hydrogen bound together with electrons. By this hypothesis he says that "the nucleus of the helium atom is built up of four hydrogen atoms and two electrons," although the mass of the helium atom is less than the sum of the masses of the four hydrogen atoms which enter into it. But since mass cannot be annihilated, the deficit can represent only the mass of electrical energy set free in the transmutation. "We can therefore," he continues, "calculate the quantity of energy liberated when helium is made out of hydrogen. If 5 per cent of a star's mass consists originally of hydrogen atoms which are being gradually combined to form the more complex elements, the total heat liberated will more than suffice for our demands and we need look no further for the source of a star's energy."

This is contrary to our cheerful generalization in regard to the requirement of energy for atomic synthesis and its liberation when atoms disintegrate. Professor EDDINGTON admits that the synthesis of radioactive elements must be endothermic, although he claims that of helium to be exothermic. The rule would seem to work both ways or rather to be no rule at all in regard to the elements. But whether ASTON is right that all atoms are made up of hydrogen plus electrons, or HARKINS is right and they are composed of hydrogen and helium, or LANGMUIR is right and the electrons dance a quadrille in pairs and octets, or BOHR is right and they waltz forever, we have a present question in the integration or compounding of atoms just as we have in their disintegration. All authorities agree that in the presence of positive charges there exists a great, unknown code of behavior among electrons. They organize and arrange themselves under rules that are not yet clear, but in which the Quantum Theory may be involved. And electrons are not to be despised. They are very small, but only by comparison with atoms. In the picture of an atom, magnified to the diameter of a mile, which Dr. IRVING LANGMUIR described when he received the Nichols medal at the Chemists Club, the electrons had a diameter of five feet, whereas the nucleus was no bigger than a walnut.

That imaginary electron, five feet in diameter, is endowed with energy. Compared with the nucleus of the atom, which may contain anywhere from one to ninety-two positive charges, it is very big indeed. To call electrons atoms of electricity does not explain them. We might as well call them John or James or Warren Gamaliel. It is merely a name. They are replete with energy of an electro-negative character. And as for the nucleus or nut at the center, the electro-positive energy is still more concentrated.

We have no recognized aggregations of positive charges set free as positive electricity, but who shall say that there is no such thing? The single positive charges which Sir ERNEST RUTHERFORD drove out from an atmosphere of nitrogen which became first hydrogen ions, and then hydrogen atoms, may have come pretty close to being a positive electric discharge. Suppose, then, a vast number of such hydrogen ions should meet with a vast number of electrons, would anything happen? Might conditions be found under which the single positive charges would aggregate themselves into the

nuclei of more complex elements? If such conditions were brought about, what would happen to those of us who were conducting the operation? Should we undergo a transformation similar to that which would be brought about by the explosion of 150 tons of dynamite in our presence? Or would the passion of electrons when confronted with positive charges to organize themselves into pairs and octets, or whirling rings or whatever their habit is, demand, require and take so much energy as to reduce the temperature to -273 deg. C. and thus to repeat the legend—provided only we had a fair maid in the laboratory—of *The Sleeping Beauty*? Or would it be hot infinitely beyond life or cold beyond death, according to the element produced?

A Suggestion

To Western Chemists

AN INFLUENCE that will have an important effect upon the industrial development of the West is the success of the co-operative associations whose object is to obtain favorable economic conditions for the financing, handling and marketing of agricultural and other products. The California Associated Raisin Co. and the California Fruit Growers' Exchange, to mention but two, are nationally known through the extensive advertising of their products, "Sunmaid Raisins" and "Sun-Kissed Oranges." These and other co-operative associations are managed by keen business men, and it is not surprising to find that they have employed engineers and chemists to help solve some of their production problems, such as the drying of raisins and the utilization of byproducts. Thus the Exchange Byproducts Co., operated for the benefit of the citrus fruit growers, with a plant at Corona, Cal., is producing 3,000 pounds of citric acid daily, also lemon and orange oil, from cull fruit. Alcohol, edible oil and fuel have been made from the capstems and seeds of raisins. Such associations, the outgrowth of unity of interest, have brought about a degree of development, particularly in the utilization of byproducts, that could not otherwise have been attained. They have, therefore, effectively stimulated a co-operative spirit through the western section of the country.

This spirit has permeated the electrical industry—the power companies, the dealers, and, through the "self-interest" appeal, men in other lines of business—and all are co-operating in the problem of raising the seventy-five or more million dollars that will be needed yearly if development in the electrical industry is to keep pace with the demand that will be placed upon it. The future market for electric power has been accurately estimated through the co-operation of the power companies.

Industrial development in the West will be rapid during the next few years and there will necessarily be an increase in the consumption of chemical products. This demand, together with that which can be developed in the Orient, will be sufficient to create the beginnings of a well-rounded chemical industry on the Pacific Coast. Although the manufacturing chemist has, as a rule, been secretive and self-sufficient, it may be that the apparent advantages of co-operation in the agricultural and electrical industries will not escape the observation of Western chemical manufacturers; at least it is hoped that they will profit by the example set by the industries cited.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

London, Oct. 13, 1920.

WHILE the threat of a coal strike persists the condition of chemical markets and of the industry generally remains very unsettled. Buyers are still satisfying only their most pressing requirements and as a result prices show a general decline aggravated by increasing Continental and American competition and difficulties due to the exchange situation. On the other hand, business is certain to be brisk as soon as the depression has passed, as stocks are very low, and although the falling off in the textile markets is an adverse factor, good business, especially on export account, is expected by the end of the year.

SULPHUR AND SULPHATE FROM GYPSUM

The high price of sulphur has revived interest in the problem of utilizing the sulphur contained in British gypsum deposits and in those located in British colonies. It was reported shortly after the armistice that in Germany the Farbenfabriken Bayer had roasted gypsum with silica and powdered coal in a rotary cement kiln, passing the sulphur dioxide produced into its contact acid plant and utilizing the residue for the manufacture of cement. This process appears to have been abandoned owing to difficulties in the contact acid plant. On the other hand, Wride, in the *Chemical Age* (London) of Jan. 3, refers to various patents and a new process of making sulphate of ammonia by the interaction of gypsum with ammonia and carbon dioxide, and this process is likely to be tried on a semi-commercial scale in the near future. A third method of utilizing the gypsum is the manufacture of sulphuretted hydrogen gas via calcium sulphide and in this way it would be possible actually to manufacture sulphur at a low cost by burning the sulphuretted hydrogen in a Claus kiln or alternatively completing the combustion to sulphur dioxide and passing that gas into a chamber or contact plant. The cost of the coal or other fuel required in these processes is lower in many of the British colonies than in this country and such a process is therefore of greater importance in the colonies where the cost of American or other imported sulphur is increased by freight charges, and the development of the processes should therefore be of particular interest to American exporters.

"DIRECT" PROCESSES FOR SULPHATE OF AMMONIA

Sulphur economics are also reflected in the various processes which are being devised to utilize directly the sulphur and ammonia in coal and to eliminate the use of sulphuric acid as such in the manufacture of ammonium sulphate. In July, 1914, the writer had the opportunity of inspecting at the Gutehofnungshütte one of the first Feld plants in which the crude coal gas was treated with ammonium polythionate with subsequent formation of sulphate of ammonia, free sulphur and sulphur dioxide, the latter being used again in a cyclic process. This plant had a capacity of two tons per day of sulphate of ammonia and the writer was greatly impressed at the time by the excellence of the chemical engineering work and the general efficiency shown by the designers. In spite of this, the Feld process seems to have proved too complicated in

practice, and the most likely successor is that now being worked out under the direction of Prof. J. W. Cobb, of Leeds University. A plant having a capacity of one ton of ammonium sulphate per day is now in operation, the process consisting in treating the coal gas with a solution of zinc sulphate to produce ammonium sulphate and zinc sulphide. The zinc sulphide is roasted and the sulphur dioxide used again to regenerate zinc sulphate from the zinc oxide obtained in a previous roasting. The sulphuretted hydrogen and ammonia in the coal gas are thus utilized, and it is understood that the process is now technically successful.

Other investigators are turning their attention to the manufacture of ammonium sulphite from gas liquor, and using sulphur dioxide gas obtained from spent oxide or any other convenient source. It has been found that under suitable conditions ammonium sulphite can be oxidized with reasonable rapidity to ammonium sulphate, the latter being present to the extent of over 90 per cent after a few days and the remainder of the ammonium sulphite being almost completely oxidized during storage. In this way the cost of manufacturing the sulphuric acid usually required is avoided, but in the case of a market so conservative as fertilizers considerable time must elapse before users can be expected to take up large quantities of a product containing small quantities of ammonium sulphite. This is not surprising in view of the fact that while in some quarters experiments have shown that ammonium sulphite is just as good a fertilizer as the sulphate, other experts have adhered to the opinion that the sulphite is to some extent a plant poison. It would seem that further work on this method should lead to valuable results and substantial economies.

AMALGAMATION OF TRADERS' ASSOCIATIONS

Reference has already been made in these notes to the rival organizations representing chemical merchants (see *CHEM. & MET. ENG.*, July 7, p. 33, and Aug. 4, p. 181). Under pressure of the Board of Trade, which was naturally disinclined to treat with more than one such body, it is now probable that the British Chemical Trade Association and the Chemical and Dyestuff Traders Association will be able to compose their differences and amalgamate into a completely representative body. Meanwhile the latter body has been doing good work by outspoken criticism of the forthcoming imports restriction bill, under which it is intended to allow dyestuffs to be imported only under license.

It is probable that there will be a long and bitter controversy on this and kindred matters when the bill is introduced into Parliament.

PROGRESS OF CHEMICAL INDUSTRY CLUB

The second annual dinner of the Chemical Industry Club is to be held at the Connaught Rooms on Nov. 19, and Sir William Pope is to take the chair on this occasion. Sir William Pope is the president of the Federal Council of Learned and Scientific Societies and that body has recently expressed sympathy with the objects of the club and three of the members of the council have been co-opted on to the club committee. The club now has 750 members and its future prospects are very bright. Reciprocal membership has been arranged with the Chemists' Club of New York.

The Chemistry of Cellulose and Its Compounds From the Colloidal Standpoint*

A Concise Descriptive Summary on Structure, Electrical and General Chemical Properties, Hydration, Oxycellulose—Action of Sulphuric Acid, Zinc Chloride, Ammoniacal Copper Oxide, Carbon Disulphide and Caustic Soda, Nitric Acid and Acetic Acid — Dope Solutions

By GUSTAVUS J. ESSELEN, JR.

CELLULOSE is one of the common materials of nature. It forms the structural basis of the vegetable world. If we consider the ultimate unit—that is, the cell—cellulose forms the cell wall, and is therefore to be distinguished from the rest of the plant, which is made up of the contents of these cells. It may be isolated in the laboratory by alternate treatments with chlorine and a weak alkali like sodium sulphite. The chlorine treatment decomposes the lignocellulose to water-soluble materials and the alkali hydrolyzes pectic bodies and dissolves the non-cellulose products from the preceding treatment.

STRUCTURE

The physical structure of cellulose varies widely, and a detailed discussion of this property is beyond the scope of this paper. In any consideration of cellulose, however, one should constantly keep in mind the fact that all its modifications have one common characteristic, viz., their colloidal character. It will be recalled that the two chief characteristics of colloidal substances are first, that they are heterogeneous, and second, that the ratio of surface to mass is a high one. As an example of the first of these, it may be noted that cotton fibers, when viewed under a microscope by polarized light, are seen to be physically non-homogeneous, and are of extremely fine structure.

As the typical cellulose and probably the purest form which occurs in nature, it is of interest to consider briefly the structure of the cotton fiber. These fibers, under the microscope, are seen to be flat, ribbon-like bands which are somewhat twisted and subjected to certain internal strains. These strains are probably longitudinal tensions which can be released by the action of solvents. Harrison, in the *Transactions* of the National Association of Cotton Manufacturers (1916), has pointed out that the cotton fiber is made up of four parts:

- (1) The outside membrane, which is not soluble in Schweitzer's reagent.
- (2) True cellulose.
- (3) Spiral fibers, all close to the outside membrane; these are not readily soluble in Schweitzer's reagent.
- (4) Insoluble matter occupying the core of the fiber.

It seems probable that those portions other than the main bulk of the fiber are cellulose in a different colloidal state. In other words, cotton fiber consists of a complex structure of cellulose in different physical states, and contains fatty, protein and mineral matter, partly in the central canal and partly dispersed through-

out the fibers. Cellulose from wood is a mixture of this typical cellulose with other celluloses less stable and less resistant to reagents.

ELECTRICAL PROPERTIES

When cellulose is immersed in water it assumes a negative charge. This probably is to be explained by the existence of a positive residual valency in the cellulose. As it is bombarded by hydrogen and hydroxyl ions the positive hydrogen ions are repelled, but the negative hydroxyl ions condense on the surface. These quickly rebound, but, as Langmuir has pointed out, owing to the fact that there is necessarily a time lag between the striking of the fiber and the rebounding, there is a higher concentration of these hydroxyl ions on the surface than in the main body of the liquid. In other words, hydroxyl ions are adsorbed. An illustration of this is seen in the fact that after a very dilute solution of sodium chloride is filtered through absorbent bleached cotton the filtrate is found to be a dilute solution of hydrochloric acid. In other words, the hydroxyl ions adsorbed on the cellulose have sufficient residual affinity to attract positive sodium ions from the solution and hold them in the vicinity of the cellulose fiber. A similar effect is observed when a very dilute sodium hydroxide solution is filtered through absorbent bleached cotton. In this case the filtrate is pure water. There will be frequent occasion to refer to these electrical properties in the explanation of the chemical behavior of cellulose.

GENERAL CHEMICAL PROPERTIES

Cellulose has the empirical composition $C_6H_{10}O_5$ and belongs, therefore, to the class of carbohydrates. Its molecular weight has never been determined, and accordingly the number of $C_6H_{10}O_5$ aggregates in a molecule is not known. The simplest point of view, as regards molecular weight, seems to be the modern one of Langmuir, which would regard the whole colloidal cellulose particle as a *colloid molecule*, consisting of large aggregates of atoms or group molecules held together by secondary valence.

The property of cellulose on which its greatest usefulness depends is its general chemical inertness. Modern theory explains this by the difficulty in making it take on or give up an electron. Under certain conditions, however, it does react, and then behaves like an amphoteric compound, exhibiting the property of a weak acid and a still weaker base. This behavior is generally explained on the ground of the mutual effect of the hydroxyl groups on the $-CO$ and $-CH_2$ groups which are not far removed in the molecule. In view of the general inertness of cellulose, an almost paradoxical

*A paper presented at the Seminar of A. D. Little, Inc., Cambridge, Mass.

behavior has recently been noted by Cross and Bevan, who showed by subsequent acetylation that two samples of cellulose, identical except for the fact that one had been boiled in distilled water for two hours and then dried, exhibited markedly different chemical characteristics. Besides this there is additional evidence pointing toward the conclusion that any treatment to which cellulose is subjected, either physical or chemical, modifies its chemical activity.

When treated with dilute aqueous acids or alkalis at room temperature, cellulose adsorbs the acid or alkali from the solution, accompanied by a very slight rise in temperature. It also readily adsorbs barium hydroxide from solution, as well as basic oxides from solutions of lead, zinc, copper, tin, aluminum, iron and chromium salts. The action of mineral acids at higher temperatures and concentrations will be taken up later under the heads of hydration and hydrolysis. The explanation of these varied chemical phenomena has already been referred to in the consideration of the electrical properties of cellulose. In this connection it is well to keep constantly in mind the fact that these electrical phenomena are exhibited at the surface, and are, accordingly, more pronounced in a colloidal material, such as cellulose.

HYDRATION

When cellulose is acted upon by acids a change occurs which is generally referred to as hydration. Its exact nature, however, has not been established. There are certain interesting experimental facts which may be noted before considering the theoretical aspects of the matter. It is a general phenomenon that when cellulose is treated with mineral acids the strength of the cellulose is greatly impaired. Very often, also, its affinity for basic dyes is greatly increased. For example, after treating with 1 per cent sulphuric or phosphoric acids and subsequent drying at 100 deg. C. for ten minutes, the treated portions develop a considerable affinity for methylene blue, which is a typical basic color. On the other hand, after the same treatment with hydrochloric acid, although the strength is considerably impaired, the affinity for basic dye is decreased. Accordingly the substance formed when cellulose is "tendered" by acid is not the same as the substance which causes an increased affinity for methylene blue. However, it has been experimentally demonstrated that this latter material is produced from the former by the further action of acids. The material having the affinity for basic colors is not oxycellulose, but a derivative of hydrocellulose. Harrison's opinion is that it is analogous to the material produced when cellulose is parchmentized and that it is a peptized form of cellulose—that is, a form in a higher degree of dispersion, which probably adsorbs substances of a sugar-like reducing character, formed by hydrolysis. The reducing power of these substances is usually considered to be dependent upon the latent activity of the -CO group being brought into play.

On this basis, the increased affinity for basic colors is to be accounted for by the increased surface. The non-dyeing modification formed by hydrochloric acid is sometimes referred to as a dehydration product, but it seems more reasonable to explain it on the basis of peptization, with a possible resulting lessened adsorption of hydroxyl ions. It will be noted that this observation of the two forms of hydrocellulose casts some doubt on one of the methods of distinguishing between hydro-

cellulose and oxycellulose, inasmuch as the affinity for basic colors was always considered to be a characteristic of oxycellulose.

Hydration of cellulose is not limited to treatment with dilute acids, but is generally observed when cellulose remains in contact with water for any length of time, particularly if, at the same time, it is mechanically agitated. In the beater, in the process of paper making, hydration is accompanied by some hydrolysis, but the latter proceeds more slowly. Dr. Minor, of the Hammersley Manufacturing Co., has pointed out that there is a big difference between pulp which has been hydrated by long beating and pulp which has been brought to the same degree of hydration by a short beating, followed by cutting in the Jordan. In the former case there is plenty of chance for the production of mucilaginous substances by hydrolysis, the presence of which might account for the grease-proof properties of artificial parchment paper. Dr. Minor has further pointed out that there is botanical evidence for the formation of such mucilaginous substances by the hydrolysis of the cellulose.

A complete discussion of the many examples of hydration of cellulose would require a long paper devoted to nothing else. All that can be done here is to point out that hydration follows different courses, dependent upon the physical and chemical forces which are brought to bear upon it.

OXYCELLULOSE

The name oxycellulose is applied to all products formed by the action of oxidizing agents on cellulose. Oxycellulose is even formed by the action of light in air, together with acid substances, soluble in water, which have strong reducing power. Like hydrocellulose, oxycellulose is also produced in the beater in the process of paper making, the rate at which it is formed depending upon the rate at which fresh surfaces are exposed by the cutting of the fibers. Hydration, on the other hand, proceeds at a much slower rate.

Oxycellulose reduces Fehling's solution and readily adsorbs methylene blue. It may be considered as a peptized form of cellulose in which the adsorbed substances have greater reducing power than those present in hydrocellulose. In the formation of hydrocellulose the acid used converts part of the cellulose into a peptized state, part into a peptized state and hydrolyzes a part. This is entirely analogous to the action of acid on starch. One gets, therefore, compounds formed by the adsorption of hydrolyzation products by cellulose in different colloidal states. The reducing properties of hydrocellulose and oxycellulose are mainly due to the adsorbed products; the dyeing properties are due to the colloidal state of the true cellulose portion.

MERCERIZATION

When cellulose is treated with caustic soda solution, its degree of dispersion is increased in much the same manner that gelatine swells in water. As has already been pointed out, cellulose under these conditions adsorbs hydroxyl ions from the solution, forming adsorption compounds accompanied by changes in physical state at certain concentrations of alkali. Tolman and Stearn have suggested that the swelling is due to the repulsive force acting between the adsorbed ions, forcing the cell walls farther apart. At the same time the sodium ions are held in close

proximity to the adsorbed hydroxyl ions and thus form a second layer near the surface. As the swelling proceeds, the ions tend to arrange themselves in such a way as to neutralize the original electrostatic repulsion, and finally the swelling ceases to increase. It is conceivable that the environment might be so changed, as by the addition of salts, that the swelling might either decrease or increase still further.

At the same time that the swelling is taking place a decided shrinkage is noticeable, and also an untwisting of the fiber. The shrinkage is probably due to the strains to which reference has previously been made and which exist in the natural fiber. These become active when the fiber is softened. The untwisting is probably to be accounted for on the ground that the strains are distributed, partly at least, in spiral form.

Many colloidal substances react with iodine to give products of varied colors, the color combinations varying with the degree of dispersion. A low degree of dispersion gives a yellow color; as the degree of dispersion increases the color changes through orange, red, violet, to blue. By means of this test, mercerized cotton is shown to be cellulose in a more highly dispersed state than ordinary cellulose. This observation is checked by the ultra-microscope.

It is a well-known fact that cotton mercerized under tension develops a luster. A number of theories have been suggested to account for this luster, but it has now apparently been demonstrated that it is due to the smoothness of the surface of the fiber, as compared with the surface of cotton unmercerized, or mercerized without tension. Furthermore, cotton mercerized under tension possesses a regular structure, whereas the two others do not. Fibers mercerized without tension appear darker than unmercerized fibers, when both are dyed with the same percentage of dye, owing to the fact that the round section of a fiber mercerized without tension gives no internal reflection.

ACTION OF SULPHURIC ACID ON CELLULOSE

While the decomposition of cellulose by sulphuric acid has usually been referred to as a solution process, Dr. Minor has recently pointed out that it really is not solution but adsorption, followed by peptization and a subsequent entire alteration of atomic affinities. One of the earliest observations of the action of sulphuric acid on cellulose was in the manufacture of parchment paper. In this operation the first effect is the adsorption of sulphuric acid by the cellulose to form a series of adsorption compounds, accompanied by swelling and peptization. In making parchment this process is stopped by plunging the product into water, which decomposes the sulphuric acid adsorption compounds and gives a gelatinous hydrate. It is probable that whatever concentration of sulphuric acid is used a series of adsorption compounds is formed, accompanied by both hydration and hydrolysis, which result respectively in an increase of the reducing power of the cellulose and in molecular disintegration. If the aqueous solution of these adsorption compounds is boiled, glucose and sulphuric acid are produced. With less drastic treatment, however, it has been found possible to obtain a very considerable amount of molecular degradation without freeing the -CO groups. When wood cellulose is used, in which the -CO group is more reactive, the reaction with sulphuric acid is more complicated, and yields furfural and condensation products of the latter.

When cellulose is immersed in a concentrated aqueous solution of zinc chloride, swelling is also observed. In this case the swelling is due to the adsorption of zinc oxide. That zinc oxide is adsorbed is proved by the fact that, when precipitated in water, the resulting cellulose hydrate retains 18 to 25 per cent zinc oxide, which is removable only by acid. Dr. Minor has suggested that the adsorbed zinc oxide or zinc hydroxide weakens the bonds which hold the colloid cellulose molecule together. In other words, a certain peptization is accomplished. In confirmation of this theory, it may be noted that sodium hydroxide does not effect the solution of normal cellulose, but does dissolve cellulose hydrate precipitated from its solution in zinc or copper compounds. After the initial swelling in zinc chloride solution, gentle heat is required to bring about final solution. This also is regarded by Dr. Minor as confirmatory of her idea that it is necessary to break the bonds of the cellulose gel before solution is effected. If a hydrochloric acid solution of zinc chloride is used, the cellulose dissolves at room temperature, but the solution is then accompanied by a gradual molecular breakdown. The solution is a rather unstable one, being broken up by mere dilution with water.

SCHWEITZER'S REAGENT

When treated with an ammoniacal solution of copper oxide, cellulose is rapidly attacked in the cold, forming a series of gelatinous hydrates, which pass into solution. The action is again due to the initial adsorption of copper oxide, and the explanation is probably the same as in the case of zinc chloride. The solutions are not very stable, being readily precipitated by alcohol, sodium chloride or sugar.

If the cellulose is allowed to remain in contact with the cuprammonium solution for a long time, some oxycellulose is formed and also a considerable quantity of nitrite. In other words, oxidation takes place slowly. As regards hydrolysis, cotton cellulose is not hydrolyzed by the process, but some forms of cellulose are.

VISCOSE

There is a well-known reaction by which carbon disulphide reacts with alcoholic sodium hydroxide to yield a xanthate having the general formula $(XO)C : S(SNa)$, where X represents the hydrocarbon radical of an alcohol. Cellulose is enough of an alcohol to respond to this reaction. In carrying out the reaction in practice, cellulose is soaked in an aqueous sodium hydroxide solution of about 15 to 20 per cent strength for several hours. This is preferably done out of contact with the atmosphere to avoid oxycellulose formation. The surplus liquid is then removed in a centrifuge or press, the cellulose usually retaining about three times its weight of solution. It is then broken up into small pieces and treated with carbon disulphide in a closed container, the amount of carbon disulphide used being one-half the weight of the original cellulose. After standing several hours in a cool place, water is added to the mixture, and the solid is allowed to swell. On stirring, a smooth colloidal solution may be obtained which is yellow in color, due to the presence of colored by-products. It consists essentially of cellulose xanthate. The cellulose xanthate may be precipitated with alcohol or brine and redissolved in water. One or two such precipitations yield a product dissolving in water to a colorless solution.

From the standpoint of colloid chemistry, the process proceeds in several distinct steps. The initial treatment with caustic soda is similar to that which takes place on mercerization—that is, the cellulose adsorbs sodium hydroxide and swells, the swelling being accompanied by an increase in the degree of dispersion. The resulting hydration and increased surface renders the cellulose more reactive. Then the carbon disulphide is added and a metathetical reaction occurs. Cross and Bevan have shown that the best proportions of reagents are two molecules of sodium hydroxide and one of disulphide to each $C_6H_{10}O_5$ aggregate. The usual reaction between carbon disulphide and an alcoholic alkali requires only one molecule of the alkali, so that the second molecule of sodium hydroxide apparently necessary for the reaction must remain held to the cellulose by adsorption. The product is really, therefore, an alkali cellulose xanthate. Only one of the three hydroxyl groups of cellulose seems to be concerned in the reaction. After from twelve to twenty-four hours, Cross and Bevan have shown, the proportion of cellulose to xanthate radical corresponds to one xanthate radical to two $C_6H_{10}O_5$ aggregates, and this compound passes continuously to one in which there are four $C_6H_{10}O_5$ aggregates to each xanthate radical. This latter compound represents the material which spontaneously gels from a viscose solution, as will be explained below. It is, however, soluble in aqueous alkalis.

The solution of viscose is probably to be explained as a colloidal dispersion of the alkali cellulose xanthate in water. This dispersion is not stable; it breaks up again on standing at normal temperatures. This behavior gives an excellent example of hysteresis. The viscose first forms a continuous phase—or in other words gels—and then the gel shrinks symmetrically with exudation of solvent. The material possesses remarkable power to absorb water, as will be seen when it is pointed out that as little as 1 per cent viscose in solution will form a gel, and solutions containing 12 to 15 per cent no longer shrink spontaneously.

Viscose solution may be precipitated by alcohol or brine. If the precipitate is redissolved and again precipitated it is found that the percentage of Na_2O and sulphur in the compound gradually diminishes as the process is repeated, no break being observed in the curve between the original xanthate and the cellulose hydrate, which is the limiting product. Cross and Bevan explain this by saying that the size of the cellulose aggregate gradually increases—in other words, the degree of dispersion decreases. In view of our general knowledge of the behavior of colloidal materials in general and cellulose in particular it seems hardly reasonable to suppose that the cellulose molecule increases in size in the course of such treatment. It is a general property of colloid solutions that, with mechanical treatment, the size of the molecular aggregate decreases rather than increases. Furthermore, in the case of cellulose acetate and cellulose nitrate there is evidence that the molecule is gradually broken down by repeated solution and reprecipitation. Accordingly it seems more reasonable to assume that the degree of dispersion of the cellulose is increased in the case of viscose also and to look elsewhere for the explanation of the increased ratio of cellulose to carbon disulphide and alkali.

At first sight it might seem that it could be explained on the ground that we were dealing with an adsorption compound, but those who know most about viscose

state that there is very strong evidence that the combination is much stronger than that. The only way that a true chemical compound can be assumed, in view of the gradual change in composition, would be that the molecule was so large that the removal of one molecule of sodium hydroxide would effect such a small proportional change in the total amount present as to escape detection by the ordinary analytical methods. Since we do not find it reasonable to assume a decrease in the degree of dispersion, it seems that the most reasonable explanation is to assume a very large molecule from which the splitting off of one or two molecules of sodium hydroxide would not produce an appreciable percentage change. Such behavior would seem to find an explanation if it be assumed that the cellulose aggregate formed one large molecule which, because of its colloidal nature, presented a very large surface. It would contain a large number of $C_6H_{10}O_5$ aggregates and the molecules of sodium hydroxide to which these were connected could be gradually eliminated one by one or even in larger numbers at a time and still give us what appeared like an unbroken curve. This explanation avoids any necessity of considering a decrease in the degree of dispersion on the one hand, or any consideration of the compound as merely an adsorption one on the other hand.

Another way of coagulating viscose is by heat. When evaporated at a low temperature a solution of viscose gives a water-soluble residue. If heated to 80 or 90 deg. C. a viscose solution coagulates, and if dried at this temperature gives a residue which is not soluble in water. In either case an analysis indicates that more water is adsorbed by such residues than by the original cellulose. This seems to indicate an increase rather than a decrease in the degree of dispersion. That it really is an increase in the degree of dispersion is further indicated by the fact that the product dyes more readily, is more easily acetylated than normal cellulose and also adsorbs a larger amount of sodium hydroxide from solution.

CELLULOSE NITRATE

When cellulose is treated with concentrated nitric acid a true nitric acid ester is formed. Since the cellulose remains solid during the treatment, one of the factors determining the degree of nitration is the surface exposed. Probably the most common way of modifying the amount of surface is to add concentrated sulphuric acid, which is adsorbed by the fiber, and not only aids the reaction by increasing the degree of dispersion of the cellulose but also acts as a direct catalyst of the esterification. The highest nitrate known is the one containing three nitrate groups for each $C_6H_{10}O_5$ aggregate. This is usually referred to as the hexa-nitrate, and is the one used as an explosive. There seems to be an unbroken series of compounds with steadily but gradually decreasing amounts of combined nitric acid from this point down to hydrocellulose. As just mentioned, the compounds with the highest nitrogen content are among our best explosives. Those with an intermediate amount form the basis of the nitrocellulose plastic industry, while those with the lowest nitrogen have no particular commercial significance.

From the colloidal standpoint, the most interesting nitrates are those of an intermediate nitrogen content, which serve as raw material in the manufacture of celluloid. This industry affords as fine an example of applied colloid chemistry as there is to be found.

There are two general methods of making celluloid. In the first pyroxylin is combined with an alcoholic solution of camphor by working under heated rolls. A considerable amount of alcohol has to be used and the solvent loss is high. In the other method, which is the more usual American process, the moist pyroxylin is intimately ground with about one-quarter its weight of camphor. The water is then expelled by pressure and after the resulting cake has been broken up it is slowly sprayed with denatured alcohol and thoroughly stirred at the same time. Alcohol amounting to about 10 per cent of the weight of the pyroxylin is ordinarily used. The resulting mixture is allowed to stand for some hours to allow for proper impregnation by the alcohol and is then worked on warm rolls until translucent, when it is pressed into slabs and sheeted or given some other form. It is finally seasoned in driers at 50 deg. C. to remove any volatile solvent which may remain. From the colloid point of view, the finished product is a true colloidal gel.

ACTION OF ANTI-ACIDS IN CELLULOID

One of the difficulties of the celluloid industry is that there are present, unless great care is taken, unstable compounds formed during the nitration. These have a tendency to decompose and set free acid, which, in turn, tends to act catalytically to decompose the main body of the material. To counteract this tendency organic compounds of a basic nature are added. They usually have some slight solvent action on the nitro-cellulose, and therefore are presumably dispersed throughout the mass. As they are substances usually thought of as crystalloids it is possible that they may be present in a molecular degree of dispersion, although it seems more probable that they will be in a colloidal degree of dispersion.

Schwarz makes the statement that an anti-acid is the more effective the larger its particles are and the more colloidal its character. From our knowledge of colloid materials in general it would seem that his statement was contrary to the general conception, because the larger the particles the less the surface, and where, as in a gel, diffusion is slow the effectiveness of the anti-acid would have to depend upon the amount of surface exposed. In other words, in gels where the rate of diffusion is slow we have to depend much more on proximity for a chemical action than in true liquid solutions where diffusion is comparatively rapid and where mechanical agitation is readily possible.

Some basic organic materials have a tendency to crystallize in the gel. These, of course, would not be expected to be so effective as materials which remained in the colloidal or molecular state of dispersion. Contrary to Schwarz, it would seem more reasonable to expect an anti-acid to be more effective the finer its particles and the greater its degree of dispersion.

CELLULOSE ACETATE

An acetic acid ester of cellulose results when cellulose is treated with acetic anhydride in the presence of a catalyst such as zinc chloride, sulphuric acid, methylamine sulphate, etc. There are two general methods of producing cellulose acetate, both of which have a number of variations. One results in a fibrous cellulose acetate resembling in outward appearance the original cotton used as raw material; the other gives a granular product. Both have this in common, that the catalyst is adsorbed on the fiber and presumably facilitates the

reaction not only because of its true catalytic effect, as exhibited in any esterification, but also because it causes a swelling and probably an increase in the degree of dispersion of the cellulose. Very frequently, in practice, time is allowed for this adsorption of catalyst and resulting swelling before the acetic anhydride is added. That the degree of dispersion of the cellulose is really modified by the reaction is indicated by the fact that the longer the preliminary treatment the more rapid the reaction when the anhydride is added and the less viscous the solutions of the product.

In making the granular form of cellulose acetate, cellulose, usually in the form of cotton, is treated with a mixture of acetic acid, acetic anhydride and a suitable catalyst. The acetic acid acts merely as a carrier and takes no part in the reaction. As mentioned above, the catalyst dissolved in acetic acid is frequently mixed with the cellulose some time before the anhydride is added, although in other cases all are added together. Since cellulose acetate is soluble in acetic acid, the cellulose dissolves as the esterification proceeds. Samples are taken from time to time and when the desired solubility has been attained the reaction is stopped by adding an excess of water, which destroys any remaining anhydride and precipitates the cellulose acetate.

In the earlier processes the acetate thus formed was the tri-acetate, which corresponds to the hexa-nitrate. It later developed that, owing to their wider range of solubility, the acetates of most technical usefulness were those with a somewhat lower acetyl content than would correspond to a hexa-acetate on the C_{24} basis, but higher than would correspond to a tetra-acetate. These were at first prepared by adding small and carefully regulated amounts of water and sulphuric acid to the solution of cellulose acetate. As before, when the desired solubility was attained, the product was isolated by precipitation with water. While, outwardly, this secondary treatment is one of partial saponification, actually it is much more intimately connected with the colloid properties of the cellulose acetate. The reason for this is that an equivalent degree of saponification obtained by methods not involving the solution of the acetate does not give a product with the same wide range of solubilities. The effect may very possibly be connected with the opening up of the molecule in such a way as to make the $-CO$ group more reactive, because it results in a greatly increased solubility in acetone.

In preparing cellulose acetate in fibrous form it is given a preliminary treatment with sulphuric acid dissolved in glacial acetic acid, this step being similar to the one for preparing granular cellulose acetate. During this treatment the cellulose adsorbs sulphuric acid to such a degree that the amount adsorbed has to be taken into account in making up the bath for the following run. After removing the surplus preliminary bath in a centrifuge or press the cellulose is immersed in a mixture of acetic acid, acetic anhydride and some non-solvent hydrocarbon. The sulphuric acid catalyst, being adsorbed directly on the fiber, is in a particularly favorable position to hasten the reaction. While the proportion of non-solvent is so regulated that the cellulose acetate does not dissolve, the conversion is accompanied by a marked swelling and by a noticeable change in the index of refraction. When the product has reached the desired degree of solubility the surplus liquid is removed, usually in a centrifuge, and the residue is thoroughly washed with water. The product is cellulose

tri-acetate, and in order to render it soluble in acetone it is subjected to a partial saponification, as in the case of the granular form described above.

SOLUTIONS

When cellulose acetate is dissolved in an organic solvent a colloidal solution is obtained in which the cellulose compound is dispersed in the solvent in the form of a lyophile colloid. In common with all lyophile solutions, it is noticed that the viscosity of any given solution increases at a very much more rapid rate than the concentration of the solution. Furthermore, in common with all lyophile solutions, the viscosity of these solutions gradually decreases when they are subjected to mechanical treatment, such as shaking or pressing through capillary tubes.

This is sometimes explained as indicating a sort of structure even in the liquid and as being connected with liquid membranes which surround the colloidal particle. That it really also affects the substance which is in the dispersed phase is indicated by the fact that when a given sample of cellulose acetate is dissolved, which necessarily involves a certain amount of mechanical treatment in the way of stirring, and is then recovered from the solution in some manner, either by evaporating the solvent or by precipitation in a non-solvent and drying, the recovered cellulose acetates give solutions of a lower viscosity than solutions of similar concentration made from the original acetate.

Furthermore, in common with other lyophile colloids, cellulose acetate solutions show rapid changes in viscosity with variations in temperature, and the viscosity of the solution is influenced by its thermal history. It is very interesting to note that in making up lacquers or other solutions in which gums are included as well as a cellulose ester it makes a decided difference in the finished solution whether the cellulose ester is added to the solvent first or whether the gum is added before the cellulose ester. Sometimes the effect is so marked that if the gum is added to the solvent first the cellulose ester will not dissolve in the resulting mixture, but if the cellulose ester is added first the gum can be readily dissolved afterward. In other words, the cellulose ester is not soluble in the colloidal dispersion of the gum in the solvent, although the gum may be dispersed in the solution of cellulose ester. From this it would appear as if the cellulose ester and solvent formed the dispersion medium, and the gum the dispersed phase, and that it was not possible under the conditions cited to obtain a mixture in which the solvent, plus gum, was the dispersion medium with the cellulose ester as dispersed phase.

The colloid chemistry of cellulose acetate plastics is the same in its essential principles as that of celluloid, and accordingly need not be considered further at this point. It may be of interest, however, to consider briefly what happens when a solution of cellulose acetate evaporates, as for example in the drying of lacquer or airplane dope, or in the manufacture of continuous films such as are used for photographic purposes. In the simplest case the cellulose acetate is dispersed in the solvent. As this is spread out on a surface to dry the solvent gradually evaporates, and finally at a certain concentration a gel is formed—i.e., the dispersed phase and the dispersion medium both form continuous phases. The solvent continues to evaporate, until finally we reach a condition where the solvent becomes the dispersed

phase and the cellulose acetate the dispersion medium. This may very well be the situation in films which have become brittle.

If, on the other hand, we were to start with a cellulose ester solution containing, in addition to the cellulose ester and solvent, some material analogous to camphor which, though solid, was still a solvent of the cellulose ester, then on continued evaporation of the liquid solvent from the gel the solid and non-volatile solvent would still remain, and we would still have a true gel with two continuous phases, which presumably would not be brittle.

In selecting such a solid non-solvent it is desirable to select a material which is miscible with the cellulose ester over a wide range of proportions, for certain such materials are known which, although acting as camphor substitutes in certain concentrations, still, if these concentrations are materially increased, tend to form a crystalline deposit which, of course, renders the combination unfit for practical purposes.

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Production of Gum Turpentine and Gum Rosin

The Bureau of Chemistry makes public the following figures showing the production of gum turpentine and gum rosin during the 1919-20 season by states. The unit for turpentine is the cask of 50 gal.; for rosin, the round or still barrel of approximately 500 lb. gross weight.

State	Turpentine Production, Casks	Per Cent	Rosin Production, Round bbl.	Per Cent
Alabama.....	38,100	10.4	126,000	10.2
Florida.....	136,900	37.4	457,500	37.0
Georgia.....	73,900	20.3	250,600	20.3
Louisiana.....	68,700	18.8	232,000	18.7
Mississippi.....	29,500	8.0	102,800	8.3
North Carolina.....	600	...	2,200	...
South Carolina.....	1,100	0.5	3,400	0.5
Texas.....	17,200	4.7	62,500	5.0
	366,000	100.0	1,237,000	100.0

The total production for the 1918-19 season was 341,000 casks of gum turpentine and 1,115,000 round barrels of gum rosin.

Watch Oil From Petroleum

The K. & J. Oil Co., of Canton, Ohio, has begun the manufacture of watch oil from crude petroleum of the Mecca field. The process was devised by Dr. C. F. Mabery, of Cleveland, Ohio, and affords a product which is said to be entirely satisfactory for chronometric lubrication. Hitherto watch oil has been prepared from the maxillary fat accumulations of the porpoise, and has sold for approximately \$250 per gal.

The Blast-Furnace Hearth*

A Wide Hearth Permits Steeper Bosh and Flatter Stack Lines With Many Resulting Economies, Especially for Smelting Mesaba Ores—Operating Data, Construction Details and Theoretical Considerations Point to Its Definite Superiority

BY WALTHER MATHESIUS†

ON THE theory of the blast-furnace process and its chemical reactions our technical literature contains many able contributions, but little has been said for years about the scientific factors pertaining to furnace design. Perhaps the statement was made occasionally that a blast furnace must afford the opportunity for a uniformly intimate contact between the iron-bearing materials of the descending stock column and the furnace gases rising from the hearth. Just how this was to be accomplished, however, what specific features should be embodied in the furnace lines to attain this end, has so far been left almost entirely to the practical furnace man to find out. Thus blast-furnace design has to date been a rather exclusively empirical development. To the practical furnace operator belongs the credit for the accomplishments in this respect as obtained by departing from the older standards, to which the engineer, as a rule, was wont to cling.

However, with a number of examples in successful operation for a period of years, theory may now safely come to the front and demonstrate that its laws were violated in the past, or that the successful development is logical and correct, its accomplishment scientifically permissible. In this manner I shall attempt to show the development of larger furnace hearths to be a logical advancement of the art in its endeavor to design furnaces which will offer the least possible resistance to a rapid and uniformly regular descent of the stock, and which at the same time will permit the furnace gases to rise through this stock column with equally regular and uniform velocity and distribution.

HEARTH ORIGINALLY A RECEPTACLE FOR IRON

Going back in history, we find that the earliest types of blast furnaces, used in charcoal practice with cold blast, were built with comparatively small hearths. On furnaces with 8 or 9 ft. bosh diameter they seldom exceeded 3 ft. in width. It is apparent that the principal and probably only consideration determining the size of the hearth in those days was to provide sufficient storage space below the melting zone for the liquid products of the operation, so as to enable their withdrawal at convenient intervals. In view of the small output of these furnaces such hearth dimensions were apparently ample. Considering the slow rate of driving, the low blast pressures and small wind volumes used, the distance of the tuyeres from the furnace center and the resultant height and slope of bosh were evidently minor considerations. Thus it may be stated that in these early days the hearth dimensions had little or no effect on the working of the furnace proper

and, therefore, the design of the latter above the tuyeres was not influenced to any extent by the size of the hearth.

Since then, and right up to our own days, the size of the blast-furnace hearth has been very largely controlled by these same considerations of providing sufficient storage capacity for the molten iron and slag. With greatly increased productive capacity and faster driving on the one hand and steadily rising difficulties of raw materials on the other, the effect of small hearth diameters in conjunction with the resultant flat or high boshes on the working and economy of our furnaces became, however, more and more apparent. Yet tendencies toward radical departures from well-established standards were for years most effectively offset by the decided aversion of furnace men, well founded on sad experiences with "hearth trouble" in the form of breakouts, to store in their furnaces more than the necessary quantities of molten materials.

This conservative policy was strengthened through the quite popular assumption that gas distribution in the stack could be controlled by maintaining the proper "blast penetration" in the hearth, and that this was largely a question of selecting the proper length and size of tuyeres. Such belief and the failure connected therewith, of recognizing the condition of raw materials in the furnace, dependent upon method of charging and furnace lines, as the principal factor governing gas distribution, has only recently been dealt with by J. A. Mohr, in his paper presented before this Institute in May, 1919.

SUPPORT OF STOCK COLUMN BY BOSH

Lastly there remained the theory that a bosh with sufficient bearing surface was needed to properly support the stock column and to prevent the premature descent of the charges into the tuyere zone, thus avoiding compression and clogging there due to the weight to be carried. This supposition was, I think, definitely controverted by H. A. Brassert, in his paper read before this Institute in May, 1914, where he termed the furnace bosh of that day the chief impediment to a free travel of the stock. Since then it has been the basic idea governing the development of the large hearth, to design, with its aid, a furnace bosh of such steepness and so short as to avoid interference with the stock movement.

Why the evolution of such designs was naturally and logically linked with the desire to use higher percentages of fine Mesaba ores may readily be understood on the basis of the following theoretical considerations:

SHRINKAGE OF STOCK VOLUME

As long as the shrinkage of the stock volume taking place during its descent from the top of the bosh to the tuyeres is such as to result in a contraction of

*A paper read before the Eighteenth General Meeting, American Iron and Steel Institute, Oct. 22, 1920.

†Superintendent Blast Furnaces, Illinois Steel Co.

TABLE I. DATA CONCERNING THE PERFORMANCE OF NO. 6 BLAST FURNACE AT SOUTH WORKS, ILLINOIS STEEL COMPANY

Date	Average Daily Product, (Gross Tons)	Pounds per Ton					Per cent Mesaba in Ore Mixture	Cu.ft. of Wind per Min. at Engines	Average Blast		Iron Analysis		Actual Yield of Metallic Mixture
		Total Ore, Scale, Cinder, Etc.	Coke	Stone	Scrap Used Over Produced	Flue Dust Produced			Temperature	Pressure at Engines	Si	z	
1918													
Oct. *	485	4,900	2,126	972	—35	21	94.2	40,870	1,194	17.0	1.49	0.029	46.29
Nov.	568	4,678	1,964	868	—38	77	100.0	44,400	1,242	18.0	1.49	0.037	48.55
Dec.	583	4,692	1,993	797	—18	254	100.0	44,613	1,147	17.6	1.54	0.040	48.05
Ave.	544	4,659	2,016	873	—29	184	98.1	43,254	1,204	17.5	1.50	0.035	47.61
1919													
Jan.	606	4,679	1,980	693	—30	277	99	43,840	1,136	17.1	1.56	0.040	48.38
Feb.	602	4,594	1,956	694	—21	303	153	44,286	1,152	16.9	1.48	0.045	49.12
Mar.	607	4,781	1,933	698	—49	298	170	44,323	1,062	16.6	1.27	0.039	48.30
Apr.	625	5,043	1,888	666	—48	336	170	45,689	1,086	16.8	0.90	0.040	45.23
May	590	4,732	1,949	742	—64	258	156	44,613	1,138	16.9	0.90	0.043	48.45
June	600	4,622	2,035	678	—42	308	180	47,839	1,163	16.4	1.02	0.035	49.23
July	600	4,590	1,981	659	—39	240	173	48,322	1,196	16.2	0.91	0.039	49.50
Aug.	605	4,631	1,955	628	—42	186	187	47,645	1,190	16.7	0.85	0.035	49.11
Sept. †	612	4,572	1,988	544	—41	251	175	47,433	1,026	15.3	1.08	0.031	49.73
Oct. ‡	361	5,293	2,398	872	—73	251	100.0	36,000	926	15.4	1.56	0.057	43.48
Nov.	597	4,440	1,942	627	—77	152	136	43,840	1,045	16.1	1.17	0.033	51.90
Dec.	597	4,538	2,052	718	—73	247	173	42,903	1,092	16.7	1.32	0.039	50.71
Ave.	600	4,661	1,972	673	—48	257	159	44,726	1,114	16.4	1.17	0.040	48.91
1920													
Jan.	625	4,603	1,890	611	—56	229	105	42,871	1,107	17.7	1.01	0.039	49.68
Feb.	618	4,575	1,976	618	—49	235	78	42,552	1,079	17.5	1.12	0.039	49.84
Mar.	632	4,510	1,891	686	—53	237	92	44,387	1,070	17.9	1.10	0.038	50.64
Apr. §	563	4,536	1,883	709	—49	211	82	43,542	1,034	17.2	1.06	0.034	50.25
May ¶	608	4,565	1,983	748	—55	216	105	43,633	1,099	17.5	0.96	0.036	50.05
June	608	4,384	1,988	753	—43	227	171	44,666	1,087	18.1	0.95	0.038	51.91
July	598	4,461	1,923	671	—42	254	171	48,933	1,045	18.0	1.01	0.036	50.96
Aug.	611	4,384	1,962	698	—51	236	169	47,839	1,067	17.5	1.01	0.041	52.01
Ave.	615	4,509	1,937	685	—49	231	122	44,803	1,074	17.6	1.03	0.038	50.67

Tons produced on lining to Sept. 1, 1920—392,594.

*Blown in Oct. 1, 1918.

† Banked Sept. 21, 1919.

‡ Resumed operation Oct. 27, 1919.

§ Banked from April 7 to 9, and from April 25 to May 3, 1920.

¶ Resumed operation May 3, 1920.

the total bulk greater than the reduction of the furnace area prescribed by the bosh angle between the two points mentioned, we may assume that the furnace bosh does not impede the stock movement.

Such shrinkage of the stock volume may be due to one of two causes. The first of these, supposedly existent in every blast-furnace operation, is the gradual consumption, above the tuyeres, of the coke by the oxygen of the blast and such metallic oxides as may still be unreduced at this point. This shrinkage will, of course, be greater with a higher coke rate and will begin at an earlier stage, which means a higher furnace level, the farther the melting zone extends upward above the tuyeres. A flat or high bosh may, therefore, be expected to interfere with the stock movement, particularly on furnaces making low-silicon iron on a low coke rate. Attempts to use high blast heats, which, of course, would aim at a concentration of the melting zone, would no doubt aggravate matters under these conditions.

The second cause of shrinkage of the stock volume in the bosh is the gradual melting of the ore and the formation of slag, which enables the liquid particles to make their way into the furnace hearth ahead of the burning coke. It may readily be seen that this shrinkage can take place to an appreciable extent only in furnaces where all or a large part of the burden consists of lumpy material, which does not disintegrate in the furnace stack but retains its shape until it reaches the melting zone. Material of this character occupies, of course, a considerable part of the furnace volume and its melting in the bosh makes this volume available for other solid materials, especially coke.

If, on the other hand, all or a large part of the burden consists of fine materials, the voids existing in the coke charge will offer sufficient volume to receive

it, so that, as the stock column descends, the space occupied by ore and coke is practically no greater than that of the coke charge alone. Consequently the melting of the ore in the bosh cannot bring about any shrinkage of the stock column. Now modern Mesaba practice with high blast heats and low fuel rates will be seen, from this purely mechanical point of view, to present all of the above-mentioned conditions which tend to minimize the shrinkage of the stock in the bosh and to retard its beginning. Thus, Mesaba practice, more than other operations, was evidently in need of lower and steeper boshes, and practical experience has shown that their adoption has in every case resulted in improved quality of product, increased tonnage, lower fuel consumption and better use of hot blast temperatures, as stated and proved by James G. West, in his paper read before this Institute in May, 1918.

One of the incidental yet not negligible advantages of the larger hearth is its greater accessibility. With increased diameter, greater peripheral distances result for arranging feed and discharge pipes for cooling water, more working space is available around the tuyeres, blow stocks and the columns, as well as between the iron and cinder runners near the furnace, so that, on the whole, the cast-house work and also the mechanical maintenance becomes easier and simpler.

PRESENT HEARTH DIMENSIONS AT SOUTH CHICAGO

In order to illustrate the extent to which hearth dimensions have grown in recent years, I might mention that the average hearth diameter of all 22-ft. bosh furnaces at the South Chicago plant of the Illinois Steel Co. was increased from 16 ft. 6 in. in 1911 to 18 ft. 6 in. in 1919, and that the best average monthly production of these same furnaces equaled 512 tons per furnace-day in December, 1911, as against 556 tons in

May, 1920. For this increased output the adoption of larger hearths is primarily responsible, no enlargement of the furnaces or important changes of lines above the bosh having been made. During the same time our fuel conditions have developed no permanent improvement, but rather have experienced a decided change for the worse. The fuel consumption per ton of iron for the two periods cited above were 2,053 lb. in December, 1911, and 2,037 lb. in May, 1920.

In this connection I wish to point out that with this development of hearth dimensions the old practice of comparing furnace performances on the basis of their daily pig iron output per sq.ft. of hearth area is no longer applicable. It will readily be understood that this method of calculating furnace ratings, while capable of furnishing reasonably equitable data where hearth sizes bore the same relation to furnace dimensions as a whole, must naturally cease to be of value as soon as hearth diameters are increased beyond the customary proportion.

EFFECT ON STACK LINES

So far this discussion has dealt with changes of hearth and bosh dimensions which did not contemplate or entail any changes in the upper or stack part of the furnace. Lately, however, larger hearths have also enabled modifications of the stack lines which were not practicable before, although their desirability had been felt for some time. Particularly for operations where soft, easily reduced ores are used which are known to have a tendency to swell under the influence of the reducing furnace gases, the suggestion had been made that the uniform descent of the stock might be facilitated by increasing the batter of the stack lining, thereby reducing any "jamming" tendencies as well as friction. One way to obtain this would seem to require merely a decrease in the diameter of the stock line. This, however, did not appear to be permissible on

modern fast-driven furnaces using a large percentage of fine ores, since the gas velocity at the stock line, which, all other things being equal, must necessarily be determined by the available area, was known to be so high in many cases as to keep the surface of the charge in more or less constant agitation. Thus the limit would be closely approached beyond which dust losses would rapidly grow to excessive proportions. The diameter of the bosh, on the other hand, appeared to be definitely controlled by the limits of hearth dimensions and bosh angles. The only means remaining, then, of obtaining at least a slight increase in the stack batter was to carry the straight stock line section down lower into the furnace and thereby reserve the relief offered by a greater outward slope of the furnace walls for that part of the travel in which the swelling of the ore and consequently the friction was thought to be most prominent.

With the removal of the assumed limitations of hearth dimensions the situation has changed. Hearth diameters of 20 ft. and larger are in satisfactory operation and the opportunity is now here to increase the bosh diameter over the rather commonly accepted 22-ft. standard without sacrificing anything in suitability of bosh angle or height. The result to be expected from such designs should, of course, be a freer working of the furnace—that is, regular descent of the charges—and, other conditions being equal, a lower blast pressure.

OPERATING DETAILS NO. 6 FURNACE

Practical results appear to verify this theoretical analysis, since, for instance, No. 6 blast furnace at the South Works, of the Illinois Steel Co., which was designed along such lines of reasoning and has now been in operation for about two years, has consistently worked with a more regular and uniformly lower blast pressure than the other furnaces at this plant under

TABLE II. DATA CONCERNING THE AVERAGE PERFORMANCE OF BLAST FURNACES AT SOUTH WORKS, ILLINOIS STEEL COMPANY
(Excluding No. 6 Blast Furnace)

Date	Average Daily Product, (Gross Tons)	Pounds per Ton						Per cent Moisture in Ore Mixture	Cu.ft. of Wind per Min. at Engines	Average Blast		Iron Analysis		Actual Yield of Metallic Mixture	Number of Furnaces in Operation
		Total Ore, Scale, Cinder, Etc.	Coke	Stone	Scrap Used Over Produced	Flue Dust Produced	Flue Dust Used			Temperature	Pressure at Engines	% Si	% S		
1918															
Oct.....	528	4,475	2,072	886	+16	270	176	72.3	43,570	1,062	17.8	1.29	0.044	49.66	9.0
Nov.....	506	4,471	2,130	837	+28	283	211	82.2	46,719	1,066	17.4	1.39	0.043	50.37	9.0
Dec.....	526	4,480	2,055	822	+17	247	178	85.5	42,120	1,074	17.4	1.39	0.039	49.89	9.0
Ave.....	520	4,473	2,084	848	+20	266	188	80.0	44,136	1,067	17.5	1.36	0.042	49.97	9.0
1919															
Jan.....	524	4,420	2,055	778	+50	282	190	85.2	41,523	1,062	17.6	1.37	0.040	49.75	8.6
Feb.....	520	4,470	2,039	838	+26	295	232	87.5	41,258	1,069	17.4	1.25	0.042	49.64	9.0
Mar.....	538	4,400	1,992	819	+27	239	226	85.4	41,907	1,070	17.2	1.27	0.039	50.56	9.2
Apr.....	556	4,330	1,885	721	+39	289	179	89.6	41,690	1,065	16.7	1.20	0.035	50.71	5.3
May.....	543	4,470	1,984	776	+26	268	100	88.5	42,983	1,050	16.7	1.28	0.040	48.81	4.5
June.....	542	4,558	2,079	724	+21	267	114	90.1	43,516	1,006	16.6	1.40	0.034	49.73	4.4
July.....	522	4,552	2,111	793	+32	258	125	87.3	41,390	1,107	16.0	1.44	0.037	49.27	5.0
Aug.....	518	4,395	2,048	779	+7	160	64	91.0	41,494	1,092	16.2	1.32	0.040	48.85	5.6
Sept.....	518	4,442	2,046	774	+19	224	123	86.8	41,396	1,045	16.5	1.38	0.037	49.36	6.7
Oct.....	484	4,664	2,091	863	-62	293	11	90.5	40,451	982	16.6	1.30	0.040	48.78	4.4
Nov.....	516	4,320	1,970	746	+49	145	82	89.9	40,831	1,039	17.3	1.44	0.045	49.75	6.2
Dec.....	516	4,299	2,030	835	+86	174	108	89.9	39,150	1,086	17.3	1.29	0.047	50.54	4.3
Ave.....	523	4,413	2,038	788	+24	241	130	88.5	41,466	1,056	16.9	1.33	0.040	48.81	6.0
1920															
Jan.....	537	4,429	2,025	776	+28	203	82	85.9	40,000	1,048	17.5	1.29	0.042	50.98	7.3
Feb.....	552	4,360	1,992	745	+23	222	128	85.5	41,044	1,060	17.5	1.38	0.041	50.99	6.4
Mar.....	562	4,382	1,953	781	+11	204	116	89.0	42,323	1,082	17.2	1.35	0.037	50.99	7.2
Apr.....	525	4,365	1,999	800	+36	184	115	90.4	40,965	966	16.8	1.43	0.039	50.74	5.4
May.....	565	4,355	2,002	819	+27	210	129	91.7	43,783	1,072	17.4	1.33	0.039	50.59	6.5
June.....	549	4,345	2,033	845	+15	214	122	88.3	43,008	1,062	17.2	1.33	0.040	51.39	6.3
July.....	551	4,320	2,001	837	+7	222	132	78.1	44,194	1,065	18.1	1.33	0.039	51.83	5.6
Aug.....	530	4,300	2,017	852	-8	222	112	73.5	41,161	1,053	16.6	1.37	0.039	51.84	5.7
Ave.....	547	4,362	2,002	805	+20	210	117	85.1	42,052	1,051	17.3	1.35	0.040	51.17	6.3

Average tons produced on linings of furnaces in blast Sept. 1, 1920—316,775.

resistance to the travel of the stock. The same inspections have in my opinion also furnished ample proof that the "phantom boshes" and "automatically reduced hearth dimensions" which have been theorized about do not exist in our furnaces. It has further been asserted that with an increase in hearth diameter it would be necessary to add to the number of tuyeres in order to avoid too great a distance between the same, since this would lead to the formation of pilasters of inactive material and an undesirable reduction of hearth area. In reply to this I can only state that on four of our furnaces at South Chicago, where the distance between the centers of adjoining tuyeres, measured on the periphery of the hearth, was 4 ft. 7½ in., 4 ft. 11½ in., 5 ft. 9 in. and 5 ft. 10½ in., inspection after blowing out did not show any such formations. On our No. 6 furnace, where with 20 ft. 9 in. hearth diameter and ten tuyeres the distance between tuyeres amounts to 6 ft. 6½ in., we do not expect to have an opportunity for inspection for some time to come. I feel justified, however, in stating that the operation of this furnace does not reveal any indications of forming such accumulations between tuyeres.

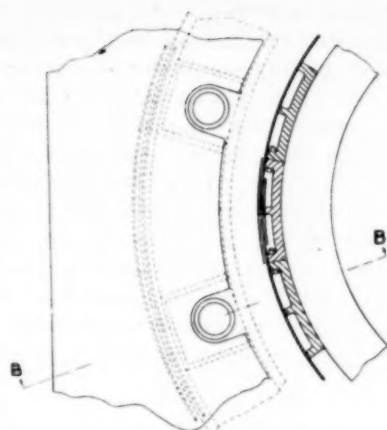
WIDE HEARTH DEFINITELY SUPERIOR TO NARROW

Another statement which has been made in literature is that large hearths are not capable of maximum heat concentration and that for this reason a poor quality of fuel would here be more likely to give serious trouble through building up in the bottom than would be the case with smaller hearth dimensions. For the same reason large hearths were said to be not as well suited for the manufacture of foundry iron and other high-silicon grades. So far I have not been able to find a satisfactory explanation or theory as to how a small hearth favors maximum heat concentration, and am, therefore, unable to discuss this question.

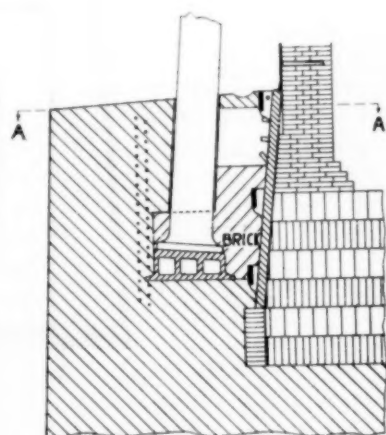
As to the ability to operate under adverse conditions of raw materials I feel that little can be added to the statements made in Mr. West's paper and the discussions presented therewith before this Institute in May, 1918, except to say that furnace operations since have only furnished additional proof of the assertions made

on that occasion. The same is true regarding the question of manufacturing foundry iron, which at that time was fully covered by G. L. Collord.

In summing up these arguments I do not intend to deny that conditions may exist in this country—and they are well known to predominate abroad—where in normal operations furnaces with high or flat boshes and small hearth dimensions work entirely satisfactorily and compare well in results with those accomplished in Mesaba practice by furnaces with larger hearths. The fact remains, however, that in a great number of instances and under different conditions of raw materials, practice and products the larger hearth has been the means of obtaining improvements in output and economy which were not realized before.



Section A-A



Section B-B

FIG. 2. REINFORCED CONCRETE GIRDLE ENCLOSING FURNACE HEARTH

CONSTRUCTION DETAILS

Concerning the constructive features involved in the design of large furnace hearths it may be said that few departures have so far been made from former standards. On the contrary, it should be emphasized that the enlargement has not imposed additional or increased stresses and duties, while in some respects the demands upon the strength and wearing qualities of the construction have actually lessened. The volume for storing the molten iron and slag being larger, the maximum height to which these latter will rise above the low level prevailing at the end of the cast must for a given production necessarily be lower. Thus less pressure is exerted per sq.ft. of bottom and hearth walls, and there is less danger of metal reaching the level of the cinder notch or of slag interfering with the combustion of coke at the tuyere level. Such advantages are distinctly to the credit of the large hearth, as they could not have been obtained by increasing the vertical distances between the iron and cinder notches and the tuyere level. These dimensions must necessarily be kept below a well defined maximum, otherwise the metal bath, being removed too far from the zone of highest temperature, becomes the cause of producing physically cold iron, which is the source of many evils and worries in steel works as well as in blast-furnace practice.

Having made provisions for storing larger quantities

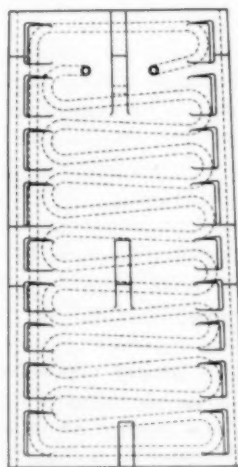


FIG. 3. CONVENTIONAL DESIGN OF HEARTH JACKET

of molten metal in the furnace and having reduced the number of casts per day accordingly, it becomes naturally of utmost importance to leave nothing undone toward minimizing the danger of iron breakouts. To obviate this most hated of all furnace troubles requires—aside from highest quality of building materials and first-class workmanship—uninterrupted, effective water-cooling and ample mechanical strength. The latter should preferably be pro-

vided in such a way that a possible failure of the former at any one point, with resultant local heating and perhaps an incipient breakout, will not at the same time reduce the strength of the mechanical bond. It is apparent that this might readily be the case where cast iron watercooled staves are placed immediately inside of a steel hearth jacket, or where watercooled hearth jacket sections are encircled by bands placed directly on the jacket itself. To eliminate this risk we have at South Chicago developed a design which has now been in use for several years and consists mainly of a circular beam of reinforced concrete placed at some distance from the watercooled cast iron hearth jacket, as shown in Fig. 2.

mitted to remain would interfere with the cooling effect and eventually lead to the destruction of such plates, may readily be removed during operation. Furthermore, these plates have the advantage of a positively controlled flow of water, no core holes being required in the baffle plates such as are generally found in the older designs, where they permit of bypassing the water around the outside edge of the plate and of depositing solid matter in the remaining passages in which the flow of water is decreased correspondingly.

It should also be noted that in the new design the baffling of the plate is arranged parallel to instead of at right angles to the line of withdrawal from the brick-

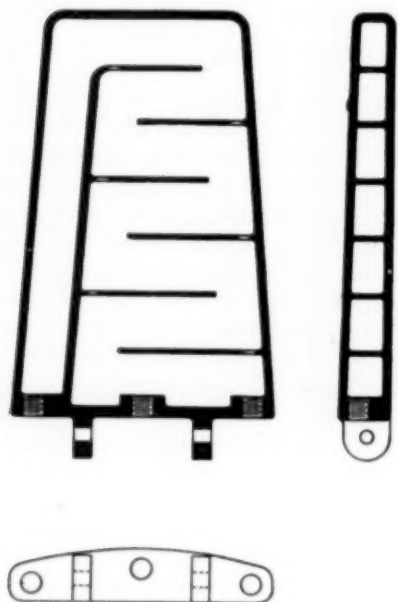


FIG. 5. CONVENTIONAL BOSH PLATE

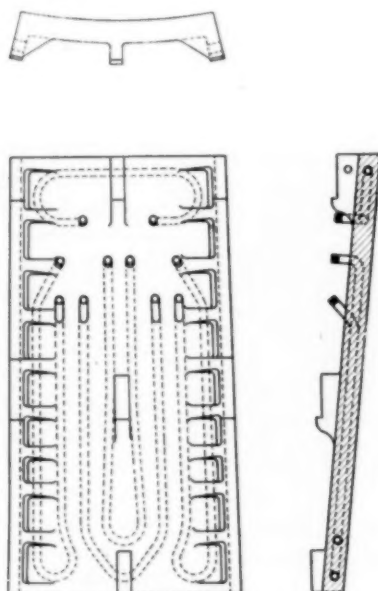


FIG. 4. REVISED DESIGN OF HEARTH JACKET

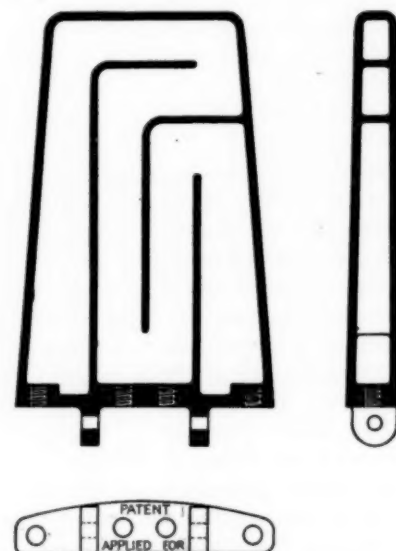


FIG. 6. REVISED DESIGN OF BOSH PLATE

The space between this concrete reinforcement and the hearth jacket is bricked up with firebrick, so that any radial pressure exerted on the hearth jacket, or expansion stresses of the latter, are directly transmitted to the concrete girdle. Provision is made by allowing clearance on the furnace side of each column so that no side thrust can be transmitted to them.

HEARTH JACKET AND BOSH PLATES

In order to reduce the chances of interruption in the watercooling of the hearth jacket segments, we have abandoned the rather conventional design as shown in Fig. 3, because it was found impossible at times to remove obstructions, carried in with the water, from the many bends and angles of the cast-in cooling pipes. In its place we are now installing the construction illustrated in Fig. 4. It will be seen that only simple hairpin loops of pipe are used in this design, so that in case of stoppage each pipe is accessible from the outside for practically its entire length. Also, should it be found impossible to remove an obstruction from one of the loops, it is no longer necessary, as before, to discontinue cooling the entire section.

Following similar lines of reasoning, we are replacing the bosh plate design as shown in Fig. 5 by that illustrated in Fig. 6. As may be seen, this type of plate is readily accessible for cleaning out, when required, by simply taking out the pipe plugs provided for this purpose. Accumulations of solid matter, which if per-

work. Furnace operators who on account of adverse water conditions encounter the necessity of frequent bosh plate changes will appreciate this feature, as it effectively supports the arched surface and prevents indentations, which formerly interfered with the removal of the plates from the brickwork.

CONCLUSION

In conclusion I take pleasure in pointing out that the successful development of the large hearth blast furnace, unhampered, as far as I am aware, by any sacrifice of former advantages, is an exclusively American accomplishment, which today is evoking the keenest interest of our competitors abroad.

The results obtained so far justify the belief that permanent progress has been achieved to the lasting benefit of the American iron and steel industry.

Standardization of Sieves by the U. S. Bureau of Standards

During October the problem of standardization of sand sieves has been taken up by the Bureau of Standards with the object of preparing standard samples for their testing. The bureau at present maintains standard cement samples for checking 200-mesh sieves and these samples may be used for the determination of correction factors for such sieves, thus comparing them with the standards kept at the bureau.

The Manufacture of Lime for Chemical and Metallurgical Purposes*—II

A Description of the Applications of the Rotary Limekiln in Burning Stone and Recovering Spent Lime—Advantages in Capacity, Low Labor and Operation Costs and Utilization of Spalls†

By RICHARD K. MEADE

THE rotary kiln which has been so universally adopted for cement plants is now being employed to a growing extent for burning lime for chemical and metallurgical purposes. For burning lime to be so used it has many points of advantage over the shaft kiln, chief of which are the low labor and fuel cost of operating and the uniformity and thoroughness with which the lime may be burned.

There has always been considerable objection to the use of the rotary kiln for the production of building lime. This prejudice is to some degree due to ignorance on the part of the builder. Fine lime is generally the result of air slaking, and as air-slaked lime is partly reverted to the carbonate, it is natural that the builder should demand lime in lumps. The product obtained by the rotary kiln ranges in size from 2 in. to dust and is indeed often much finer than this. On being supplied with this fine lime, the builder supposes that it is air-slaked lime and refuses it.

At one or two plants producing rotary-kiln lime, the lime is hydrated and sold to builders in the form of hydrate. The hydrate made from this lime differs very little, if any, from that made from the ordinary grades of shaft-kiln lime.

Where the lime is desired for chemical and metallurgical purposes, such as in the manufacture of soda ash, wood pulp, carbide, cyanamide, calcium acetate, bleaching powder, bichromates, sugar, glass, ammonia, etc., for causticizing and furnace linings and flux—in short, where lump lime is not necessary—the rotary kiln will prove superior to the shaft kiln provided the quantity of lime justifies the outlay.

The first definite proposal to use a rotary kiln for burning lime appeared in a patent which was granted to Henry Mathey of New York in 1885 (U. S. Patent 330,603) on a process of making lime which consisted in first crushing the stone to a suitable degree of fineness to pass a No. 4 or No. 6 mesh screen, then burning in a revolving furnace which he invented (U. S. Patent 325,259). This consisted of a rotary cylinder somewhat similar to the present day kiln except that the center line of the kiln was horizontal, while the kiln itself was made slightly cone shape, this latter serving just as does the inclination of the straight cylinder to work the material through as the furnace revolved.

The John G. Jones patent (U. S. Patent 832,485), taken out in 1906, specifies the use of the present-day kiln, but covers the burning of lime in a "granular condition with granules of such size as will readily pass a 1-in. mesh screen," and this phrase occurs in all his claims. In view of the fact that the use of an apparatus

cannot be patented and that Mathey had previously suggested the burning of limestone in a granular condition, it is not at all surprising that Jones, so far as I know, has never made any serious attempt to sustain his patent.

Some experiments were also made in the early days of the cement industry on burning lime in rotary kilns. About 1905 the New York Lime Co. started to burn lime at Natural Bridge, N. Y., in a rotary kiln and shortly after this rotary limekiln plants were built by both the Union Carbide Co. and the Aluminum Ore Co. There are now in operation quite a number of rotary-kiln lime plants supplying lime for chemical and metallurgical purposes.

The Eastern Potash Co. is now installing at New Brunswick, N. J., a rotary-kiln lime plant equipped with ten rotary kilns, each 8 ft. x 125 ft. This plant when completed will have a capacity of 1,000 tons of lime per day and will be the largest lime plant in the world.

The Air Nitrates Works at Muscle Shoals, Ala., is also equipped with a rotary-kiln lime plant which contains seven kilns of the above size.

The Union Carbide Co. has two rotary-kiln lime plants and no other kiln compares with the rotary one for burning lime for carbide, because of the thoroughness with which this type of kiln burns the lime. Any unburned stone in lime for this purpose not only must be decomposed with a great expenditure of power in the electric furnace but the carbon dioxide liberated destroys the carbon electrodes.

The rotary kiln is now being quite extensively used also for burning dolomite for furnace lining. For this latter purpose much harder burning is necessary than can be obtained easily in a shaft kiln. The rotary kiln is also pretty generally used for calcining magnesite in California.

LIME RECOVERY

An application of rotary kilns for burning lime of particular interest in the chemical industry is the employment of these for burning lime from the waste carbonate of lime, or "lime sludge," obtained from the manufacture of caustic soda by the action of lime on soda ash and in sugar refining. Large quantities of this waste are produced by paper pulp mills, caustic soda works and beet sugar manufactories. The rotary kiln is now being employed for converting this waste into lime in all of these industries.

The attempt to burn the waste in a rotary kiln began about 1900, when the kiln was employed in connection with driers. This combination had already been tried on wet materials in the cement industry and proved a failure. The use of driers in recovering waste was soon abandoned and the employment of long kilns, following

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Part I see CHEM. & MET. ENG., vol. 23, No. 17, Oct. 27, 1920, p. 841.

the cement practice on wet materials, was substituted. This, in connection with various schemes for thickening the waste sludge so as to reduce the water to be evaporated, has made the burning of lime waste commercially profitable.

The waste is usually received in the form of very thin sludge or slurry and it is necessary to dewater this by passing it through filter presses. The first presses employed were of the intermittent type. Recently, however, the continuous type presses have been found more satisfactory. The rotary presses are particularly convenient, as the cake may be scraped from the latter directly into the kiln. As fed to the kiln under these conditions, the material usually contains from 45 to 55 per cent water. It is desirable to reduce the quantity of water as far as possible in order to reduce the work of evaporating this water in the kiln.

Generally, producer gas is used for burning lime

carried from the press to the kiln on a belt conveyor. Recovered lime consists of small, slightly oval lumps ranging in size from that of a walnut down to dust. The color is slightly yellowish or greenish. The lumps slake quite a bit slower than rock lime and consequently causticize somewhat slower. On the other hand, the resulting precipitated carbonate of lime usually settles much more quickly. The lime will slake much more rapidly if the lumps are crushed before being added to the solutions to be causticized.

The lime will gradually pick up impurities from the process and also from the kiln lining, so that it is not possible to burn the same sludge over and over indefinitely. Instead of starting with an entire fresh lot of lime, therefore, it is the general practice to introduce a small quantity of rock lime into the system at regular intervals and to sell a corresponding amount of recovered lime or discard the equivalent amount of sludge. This loss is usually made up by adding ground

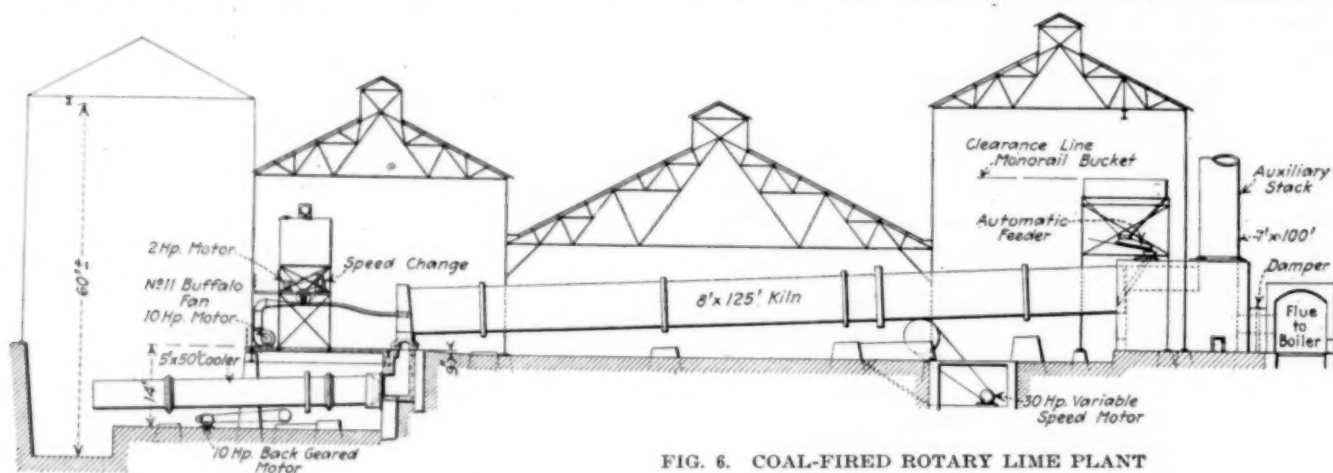


FIG. 6. COAL-FIRED ROTARY LIME PLANT

sludge. Where available and cheap, however, natural gas or fuel oil would be superior fuels. Pulverized coal is not entirely satisfactory, as the amount of ash introduced is considerable, due to the much greater quantity of fuel required to burn the wet sludge. The wet sludge in the upper part of the kiln serves to catch and retain a large part of the ash which in burning limestone would pass out of the stack.

The capacity of a rotary kiln burning alkali waste will vary very largely with the water content of the waste when fed to the kiln. If properly installed a kiln burning lime waste will have about 60 per cent of the capacity of the same kiln burning limestone—the actual amount depending to a large extent on how much water remains in the sludge.

The fuel requirements also vary with the amount of water in the sludge, but with a sludge containing 50 per cent water the amount of coal required per ton of lime will be from 800 to 1,000 lb. The amount of natural gas will range between 11,000 and 14,000 cu.ft., while the oil will range between 72 and 90 gal. The labor, power, repairs, etc., required to operate a lime-recovery plant will be about the same as are required to operate a plant burning limestone, with the addition of a man to watch the filter presses.

In many of the newer plants mechanical filters are a part of the causticizing equipment and the operation of these would be considered as part of the causticizing plant. If possible, these filters should be located so that they can feed the cake directly into the kiln, but where it is less convenient to do this the material can be

limestone to the kiln along with the lime sludge. The amount of lime necessary to replace losses usually amounts to about 5 to 10 per cent. The recovered lime, if burned at all skillfully, will contain as much caustic lime as the best lump lime made from limestone. Lime sludge usually contains a certain small amount of caustic soda and the reburned lime of course contains this soda which is so recovered, adding to the saving to be effected by the process.

The kiln used for recovering lime waste may also be used to burn lime from limestone provided the latter is crushed and there are suitable means at hand for feeding it to the kiln.

A lime-recovery plant will cost approximately \$1,500 per ton of lime recovered. This figure includes filter press, gas producer and buildings.

DESCRIPTION OF ROTARY KILN

The rotary kiln as used for burning lime does not differ in any particular from that used in the cement industry. It consists of an inclined cylinder from 6 to 8 ft. in diameter and from 60 to 125 ft. long. This cylinder is lined with firebrick and is supported on two or more steel tires which revolve on rollers. Power is received by means of a girth gear and supplied by a train of gears. The cylinder is slightly inclined from the horizontal, usually from $\frac{1}{2}$ to $\frac{3}{4}$ in. to the foot. The limestone is fed in at the upper end of the kiln and a jet of burning fuel is introduced at the lower. The limestone works its way through the furnace as the latter revolves and is burned by the gases passing

through the latter, falling out at the lower end of the kiln.¹

Fig. 6 illustrates a rotary-kiln lime plant. The stone is held in a large bin and is fed from this automatically and continuously into the kiln. The latter is heated in this case by pulverized coal. The lime falls out of the kiln into a cooler, which reduces its temperature to the point where it can be conveniently handled.

The capacity of various size kilns is given in the accompanying table.

CAPACITY OF ROTARY KILNS BURNING LIME FROM LIMESTONE

Diameter Unlined Shell, Ft.	Length of Shell, Ft.	Capacity per Day of 24 Hr., Tons	Approximate Horsepower Required*
5	60	18-20	4
6	60	25-30	5
6	100	40-50	7½
7	80	55-60	10
7	100	70-80	12½
8	125	90-100	17

* NOTE—Motors should of course be larger, as this is actual average horsepower required.

SPALLS USED IN ROTARY KILN

The advantages of the rotary kiln begin with the quarry. With the old shaft kiln, whether of the most improved type or not, it is necessary to feed the kiln with stone of a certain size. If the stone is too big, the heat cannot penetrate to the center of the lump and consequently there will be a core or center of unburned limestone. If the stone is too small, the small pieces will work their way into the crevices between the larger stone and will choke the draft of the kiln, not only decreasing very materially the output of the latter but also causing irregular burning of the stone, due to the fact that the gases are forced to seek the path of least resistance and will probably avoid the central portion of the kiln in which the fine stone is more apt to lie.

As a general rule, the stone for the shaft kiln should be brought down to a size ranging between 2 and 8 in. Where the stone breaks up in the form of slabs, these latter can be quite long provided their least dimension is not greater than 8 in.

The necessity of having the stone of this size increases very materially not only the labor but also the waste in the quarry. Where the small stone or spalls can be sent to a crushing plant or other use can be found for them, the item of waste is not so great, but where they must be thrown away, the loss from this source is considerable. Quite a number of lime manufacturers have installed rotary kilns in connection with their vertical kilns with the express idea of burning up these small stones.

The saving of labor in the quarry is very considerable. The sledging of the stone to proper size and the hand sorting and forking add much to the cost of this. Anyone with experience in such matters will appreciate the fact that stone can be crushed to 2 in. by a stone crusher much more cheaply than it can be crushed to 8 in. by hand. "Cup grease" is much cheaper now than "elbow grease."

There are also numerous limestones which do not burn very satisfactorily in a shaft kiln owing to the fact that when the heat strikes them they decrepitate

and fall into small pieces. In some cases this action is very marked, the stone being almost reduced to dust. A very good example of this is the highly crystalline limestone found in the neighborhood of Franklin Furnace, N. J., some of the purest ledges of which have never been successfully burned in a shaft kiln due to this very action. Another limestone which is difficult to burn in a vertical kiln but which can be burned in a rotary kiln is the soft, chalky limestone of central Florida.

The saving effected in the quarry by a rotary kiln depends very largely on the size of the plant. If the plant is large enough, the fact that the quarrying can be done with steam shovels will appeal to even the layman as a great saving over the process of carefully breaking down all stone to proper size by means of sledges² and then loading by hand on cars.

The earlier rotary-kiln plants nearly all reduced their stone to quite fine material—passing the 1-in. screen, or about ¾ in. and under. In the writer's opinion this is unnecessary and good results are now being obtained with stone crushed to pass a 2-in. screen. This has the advantage of saving power and simplifying the outfit required.

The power required to crush the limestone may be safely figured at about 1½ hp.-hr. per ton of limestone crushed, which is equivalent to 2½ hp.-hr. per ton of lime produced (1.87 kw.-hr.).

In small plants which would naturally employ hand labor for quarrying, a small gyratory crusher with smooth concaves and head may be used, setting this to 2-in. screening and returning the oversize to the crusher for recrushing.

As a general rule, better results can be obtained by screening out the dust from the coarse rock before burning. This increases somewhat the capacity of the kiln. This dust also contains a large part of the dirt which finds its way into the quarry, so that the writer has found its removal is of advantage in increasing the purity of the lime. In localities where water is abundant there would be no objection to washing the limestone to free it from dirt, as the wet stone would not affect materially the operation of the kiln.

Probably most chemical manufacturers will purchase their stone. In this event a good specification would be "to pass a screen with round perforations 2 in. in diameter and be retained on a screen with round perforations ½ in. in diameter."

Part III, dealing with Operation, will appear in a subsequent issue.

Search for Sodium Sulphate

Active prospecting for sodium sulphate has begun in the West and the Bureau of Mines is receiving numerous inquiries regarding its occurrence and its characteristics as found in nature. The bureau's chemists are at a loss to explain this sudden interest in sodium sulphate prospecting. Heretofore practically the entire supply has been the manufactured product, a considerable portion of which is a byproduct of hydrochloric acid making. Large deposits of sodium sulphate occur in Wyoming, Nevada and Utah—the "white alkali" of the semi-arid regions.

¹The construction of the kiln and its history and use in various industries was described in detail in the *Transactions* of the American Institute of Chemical Engineers, vol. 7, p. 153, and in the *Journal of Industrial and Engineering Chemistry* of September, 1914, p. 754.

²If the shaft kiln plant is large enough to justify the cost of the installation of very large crushers the steam shovel can be used here also and the limestone crushed in such crushers and sized by screens as is done by the Solvay Process Co. at Jamesville, N. Y. The waste in such a plant is large, however.

The Expansion of Glass at High Temperatures

BY W. B. PIETENPOL

THE problems met in the manufacture of optical and commercial glass have necessitated extended investigations concerning methods for determining the proper procedure and treatment of the glass during the productive stage. Relative to such research the solution of the means of determining a suitable annealing temperature is of importance depending upon the purpose for which the glass is to be used. In the manufacture of optical glass the greatest care must be exercised throughout every stage of the process in order that the glass may be homogeneous and free from strain.

Methods of determining the annealing range have been investigated by observing the disappearance of double refraction, the region of heat absorption and the rate of deformation of loaded rods. The relation of the rate of thermal expansion to the annealing temperature has also been pointed out, but without due emphasis upon the importance with which the determination of the rate of expansion bears upon the manufacture of glass. With a view of determining more definitely this relation and extending the temperature range through which the expansion of glass has been investigated, the author has carried out a series of experiments by a simpler and a more direct method than has heretofore been used.

To the engineer and industrial concern, laboratory results depending upon the measurement of minute quantities are not as acceptable as the results of experiments upon bodies comparable in dimensions with those found in the industries. Though acknowledging the refined laboratory technique of the physicist in measuring the change in dimensions of a centimeter of material in terms of the wave-length of light—i. e., of the order of one two-thousandths of a millimeter—in general there is some hesitancy in applying the results of such delicate measurements to the commercial process. This was considered sufficient reason for adopting a method by which the thermal expansion of relatively large samples of glass could be examined. The accuracy of measurement was thereby increased and the results not so dependent upon the homogeneity of the sample in question.

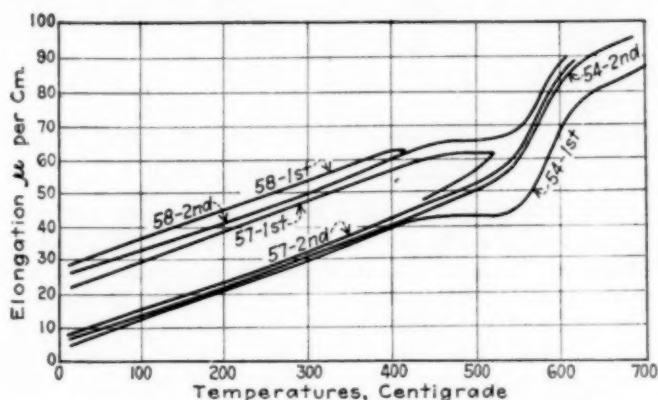
An electric furnace, 100 cm. in length and 6 cm. in diameter, was constructed with small openings about 12 cm. from the ends, through which specially designed microscopes were focused upon the samples of glass. The strips of glass were about 76 cm. long and rested upon a flat piece of asbestos rigidly supported within the furnace. By the use of auxiliary heating coils in parallel with resistances the temperature was kept uniform. As measured by thermocouples, the temperature in different parts of the furnace varied by less than 1 deg. C. during the observations. The microscopes were focused upon diamond scratches on the glass and upon small platinum particles resting upon the surface of the glass strip. By this means the temperature at which the glass began to soften could be very closely determined. The microscopes were supported upon a heavy steel frame which was kept at constant temperature during the observations.

The expansion of optical and other glass was measured from room temperature to 750 deg. C. The rate of expansion of annealed glass is nearly linear

until temperatures of 450 to 550 deg. C. depending upon the kind of glass. The rate of expansion then increases by four to six times through a temperature range of 60 to 100 deg. C. This is in agreement with the expansion determined by C. G. Peters of the Bureau of Standards by an interference method.

Measurements have been extended to higher temperatures. After the rapid increase in expansion the rate of expansion again becomes nearly linear, in general being slightly greater than at low temperatures. When the softening point is reached the rate of expansion gradually decreases and the length of the strip remains constant. At this point the glass loses its form and no linear expansion can be measured.

With unannealed glass the rate of expansion in general decreases from 50 to 150 deg. before the rapid ex-



THERMAL EXPANSION CURVES OF UNANNEALED LIGHT BARIUM CROWN, BUREAU OF STANDARDS, MELT 404

pansion takes place. This decreased rate may continue through a temperature range of 100 to 150 deg. depending upon the strain in the glass. In some instances the expansion through a range of 100 deg. is practically zero. Upon cooling, the strip of glass is shorter by a definite amount which is proportional to the strain which has been relieved. If the observations are carried to a sufficiently high temperature and the glass is slowly cooled, it becomes well annealed. A second set of measurements then taken upon the same strip of glass does not show this decrease in rate of expansion, but a nearly linear rate until the temperature of rapid expansion is reached.

This is shown graphically in the figure, which shows the thermal expansion curves of unannealed light barium crown, Bureau of Standards, Melt 404. The two curves referred to are marked 54-1st and 54-2nd. When an unannealed sample of the same melt of glass is heated to a point just below the temperature at which the rapid expansion begins (57-1st), the strain disappears entirely. The curve shows observations taken for about a hundred degrees upon cooling and the final point to which the strip of glass contracted at room temperature. Without moving the glass in the furnace, a second run was made with results as indicated by curve 57-2nd. The observations coincide with those of the previously indicated strip of annealed glass (54-2nd), showing that the annealing temperature had been reached. Curves 58-1st and 58-2nd show the results of heating the glass to a temperature below the annealing point. Thus a determination of the rate of thermal expansion may be used as a very exact method of finding the proper annealing temperature.

During the investigations which were made on the

thermal expansion of different kinds of glass, it was noted that a certain strip of glass underwent a rapid contraction soon after the rapid expansion took place. This occurred at a temperature above 620 deg. C., when the glass rested on asbestos board which had not previously been heated. Such asbestos contracts very greatly at high temperatures. This may have caused a compression in the glass sufficient to shorten the strip when in the plastic state.

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What Constitutes Unfair Trade Practice?

BY AN INTERESTED OBSERVER

THE abstract of an address by William B. Colver of the Federal Trade Commission which appears in *CHEMICAL & METALLURGICAL ENGINEERING* of Aug. 4 (p. 191), coming at the time it did, presented an interesting coincidence, since Mr. Colver's speech gives the sanction of a member of the Federal Trade Commission to just such a line of investigation as that which Minerals Separation, Ltd., sought to exclude from the testimony of Theodore J. Hoover in the recent San Francisco hearing before the Federal Trade Commission.

Among those practices which Mr. Colver enumerates as being "unfair methods against competitors" is given "false claims to patents or misrepresenting the *scope* [italics mine] of patents. Statements of this character have been at times sufficiently broad to give claimant a monopoly of an industry."

Here is stated just such a case as Mr. Hoover perceives to be that of Minerals Separation, in its attempt so to construe its patents and so to broaden their claims as to bring within their scope the process of the porous bottom cell.

When Mr. Hoover learned from his reading of the testimony being given in patent litigations just what a broad monopoly Minerals Separation was attempting to establish before the United States court, and when he realized how absolutely at variance these present claims are from any conception of the process which one would gain from the reading of a manuscript treatise which had been written by two of the inventors shortly after the invention of the process and which had been handed by one of them to Mr. Hoover at the time he was manager of Minerals Separation, for his instruction as to the process, he felt it to be his duty to divulge these gross discrepancies of statement.

The fact of Mr. Hoover's possession of the manuscript was disclosed in an affidavit made by him in certain court proceedings in connection with the Miami infringement suit. The existence of the manuscript and the inconsistencies which it reveals had thus become public knowledge.

Three fellow engineers, to whom the question was submitted, recognizing, as they did, how absolutely convinced Mr. Hoover was that he had found in the conflicting statements as contained in the Sulman and Picard manuscript and the statements now made by Minerals Separation in prosecuting its infringement suits a palpable attempt upon its part to perpetrate a fraud upon the United States court, could have arrived at no other conclusion than that it was ethical, under the circumstances, for him to divulge the contents of

the manuscript. More than this, however, Mr. Hoover was himself impelled by the spirit of most enlightened ethics, in keeping with the modern trend of thought, in which the interest of the individual, as well as that of his employer, is subordinated to the general welfare. This idea is well illustrated in Article 3 of the code of ethics proposed by the American Society of Mechanical Engineers, which reads:

He should consider the protection of his client's or employer's interests in professional matters his essential obligation, *provided these interests do not conflict with the public welfare.* [Italics mine.] *CHEM. & MET. ENG.*, June 2, p. 1042.

This code, framed to conform to modern conceptions, was drawn up by eminent engineers from San Francisco, Minneapolis, Atlanta, Boston and Baltimore and may therefore well be presumed to express a broad spirit. In its preamble and the twelve articles of the code itself the underlying principle is enunciated that the benefit of the public must come first, that of the employer second, and that of the individual engineer last.

It was indeed by the spirit of this code that Mr. Hoover was actuated, that not only the interest of the mining public, but that of the whole United States should be considered before that of his former employer, or his own personal disinclination to enter into such a controversy.

"Misrepresenting the scope of patents," says Mr. Colver, is one of the "unfair methods against a competitor," statements of such a character as would give claimant "a monopoly."

Now this would certainly appear to be just what Minerals Separation is attempting in its efforts so to broaden the scope of the claims of its patents as to include within the agitation of these patents such agitation as is incident upon the introduction of the air through the porous bottom of the cell in the pneumatic process, an agitation which the U. S. Circuit Court of Appeals says, in its Miami decision, "is not even approximately of the violence and the duration of the agitation of the patent" (*E. and M. J.*, Dec. 1, 1917, p. 956).

We have, however, in this manuscript which Mr. Hoover has brought forward statements by two of the patentees of the process which show most conclusively what was the idea of these two inventors of the process as to the agitation of their process and just what it was that their discovery had added to the art, and that was simply the manner in which the "supersaturation" of the pulp was attained by a rapid rotary agitation of such violence that the gas [air] was "whipped into the ore pulp in minute bubbles."

This manuscript is particularly important because written at a time immediately following the invention, and because it was written in a purely scientific vein and was not influenced by any such spirit of mental reservation as that which subsequently led to the entire suppression of so purely scientific a treatise.

It was natural, under the circumstances, that in pressing the case before the Federal Trade Commission against Minerals Separation it was sought to introduce this manuscript, and also natural that Minerals Separation should "object" to its introduction as "incompetent, irrelevant and immaterial."

The arguments as to the introduction of this document and as to Mr. Hoover's interpretation of it are not of moment in this connection except in so far as

Minerals Separation objected to the introduction of the manuscript on the ground that it was improper for the Federal Trade Commission, as it was expressed, "to try out patent litigations."

Such an interpretation of the situation as this by Minerals Separation is simply a play upon words. The Federal Trade Commission was making no attempt whatever to try a patent case, but simply to establish such an attempted broadening of the patent claims as is shown by Mr. Colver to constitute objectionable practice, the establishment of which fact comes well within the province of the Federal Trade Commission.

That it is the duty of the Federal Trade Commission to determine whether among other improper practices, if there are such, Minerals Separation is also attempting improperly to enlarge the scope of its patents with a view to obtaining a monopoly is clearly pointed out by Mr. Colver in his speech.

If one turns to the pages of the Sulman-Picard manuscript treatise which were cited by Mr. Hoover in his testimony before the Federal Trade Commission in San Francisco, and compares statements found upon these pages with testimony presented by Minerals Separation in the United States courts, one may well believe that Mr. Hoover had every reason to feel himself impelled to disclose the suppressed manuscript.

Limited space precludes the quotation of more than two or three examples.

On page 6 of the manuscript, in a classified list of processes, we find this classification:

- (d) Dependent on the use of more or less minute quantities of oil to "cement" gas or air bubbles to the particles so covered with an indefinitely thin film of oil:
 - Froment.
 - Sulman and Picard.
 - Sulman, Picard and Ballot.
 - Elmore (vacuum process).

On page 83 we find the following:

The second type of process, dependent on the flotation of oil particles by means of air or other gas, introduced in such a manner as to bring about a state of supersaturation in the solution, was discovered almost simultaneously by one of the authors in England and Mr. Froment in Italy, though published first by the latter.

In the Sulman, Picard and Ballot "frothing" process the same result is achieved without the employment of decomposable carbonates and acid or other gas-producing mixture; the necessary gas is supplied by means of air, which is whipped into the ore pulp in minute bubbles by means of rapid rotary agitation.

On page 94, referring to Froment and Minerals Separation "frothing" process, Sulman and Picard say:

Both these processes not only recover finely divided or slime sulphide mineral, but actually demand the presence of the same for the production of a coherent froth. The minute amount of oil added forms a film coating on the mineral which to all intents and purposes becomes part and parcel of the particle.

We have, on the other hand, the following as an illustration of Minerals Separation's interpretation of the Froment process, as presented in the United States District Court in Wilmington, Del., in which for their "thinnest possible layer" of an "ordinary oil" they chose an oil of such viscosity that it gave 13 per cent of oil upon the ore used, instead of an amount so small as to become "part and parcel of the particle," notwithstanding that Froment's instructions which had been given to Minerals Separation gave 1 per cent of oil as an example.

As to the resulting product of the Froment process,

Minerals Separation testified as follows (Miami Appeal Record, vol. 2, p. 1,455, Dr. Adolf Liebman's answer to question 472):

When you come to a scientific definition, we call froth air bubbles, collected on the surface of water or liquid. I should call the results as obtained in this way (Froment process) an emulsion, an emulsion produced by oil, some air bubbles, some mineral and some water. It may quite correctly be termed a magma, but a magma is not as definite as an emulsion. It is not a froth. When it comes to a strict definition it is not a froth.

These and many other statements, both as to the classification and description of their own and other processes, which are contained in the Sulman and Picard suppressed manuscript are found to be absolutely at variance with the entire contention of Minerals Separation in its litigation before the U. S. courts.

Moreover, the statements in the Sulman and Picard manuscript so evidently present the true knowledge and sincere convictions of these two inventors as to their own "frothing" process, as well as to the Froment and others, having been written down by them immediately following the invention, there would seem to be no question as to what any honorable engineer should do upon whom circumstances had thrust the knowledge of so monstrous a discrepancy.

Belgian Chemical Company Developments

A number of important developments and extensions in connection with the chemical and allied industries of Belgium, where, by the way, the process of reconstruction is proceeding more rapidly and infinitely more orderly than anywhere else in Europe, have to be recorded.

La Société Chimique de l'Escaut has been established, with headquarters in Brussels, to carry on the manufacture and sale of chemical products and also the sale of raw materials for use in chemical manufacture. The capital of the concern is 4,500,000 fr., the principal shareholders being La Société Anonyme des Verreries des Hamendes and La Société Anonyme Cuivres Métaux et Produits Chimiques d'Hemixen. Another new undertaking, the Belgoleum Compagnie Industrielle et Commerciale des Produits Oléagineux du Congo, has been registered at Brussels with a capital of 9,000,000 fr. At a meeting held in Brussels at the end of last month it was decided to increase the capital of the Société Générale des Produits Chimiques by the issue of new shares to the value of 6,500,000 fr.—*Chemical Trade Journal*.

Fuel of the Future

Prof. W. M. Thornton, in a presidential address to the Newcastle branch of the Institute of Junior Engineers, said that, with regard to heat, development must be looked for along the lines of new fuels. The coal age was passing, and the future of fuel was with the chemists. He referred to the possibility of tapping the earth's underground heat, and, turning to electricity and magnetism, said it was now known that all matter was made up of electrons, and the problem, at present barely conceivable, was to tap that source of electricity without going through the inefficient process of heat. The science of electrochemistry was gradually indicating lines of attack, and, if electricity could be obtained at high pressure from coal, oil or alcohol without burning, an immense advance would have been made.—*Chemical Trade Journal*.

New Deoxidizers for Steel Manufacture

Report of a Co-operative Investigation Sponsored by the National Research Council on the Function and Action of Deoxidizers, Together With Experimental Work to Find Low-Melting Mixtures of Scavenging Oxides

By J. R. CAIN*

A CO-OPERATIVE investigation was started in June, 1918, to select, according to a systematic procedure, some new experimental deoxidizing alloys for trial in steel manufacture. The original and primary motive was to contribute toward conservation of manganese in this industry, since manganese shortage was being experienced by American steel manufacturers at that time. This particular motive for the research became less urgent as time went on. Nevertheless, a knowledge of deoxidizers for steel manufacture which could, if necessary, contribute toward reducing the amount of manganese needed still seems of great importance. Many careful investigations made during the war showed that there is not available within the United States sufficient high-grade manganese ore for the needs of the steel industry, although there is a fair amount of ore suitable for making deoxidizers leaner than the 80 per cent ferromanganese which steel manufacturers prefer.

ACTION OF DEOXIDIZER

In order to give a proper perspective, it seems well first to consider briefly the mode of action of a steel deoxidizer, some of the problems which must be solved in a complete deoxidizer investigation, and, finally, some simplified investigations which could give most of the information needed by manufacturers and practical men, without requiring too great an expenditure of time and labor.

In general, a deoxidizer is added to steel to make the metal sound. In order to do this the following results have to be accomplished: Gaseous impurities must be eliminated or rendered incapable of causing blowholes and cavities; non-gaseous oxides must be reduced to metal, caused to separate as such from the bath, or made to combine with the deoxidizer or its reaction products to yield substances which can free themselves readily from the molten metal—i.e., presumably in fusible and fluid slags.

Considering somewhat more in detail the mode of action of the deoxidizer, it may be stated:

First, as to its effect on the gas content of the metal, there is little exact knowledge. In an empirical way it is known, for instance, that additions of ferro-silicon, ferromanganese or aluminum to molten steel before tapping remove the harmful effects of gases in causing blowholes. Just what happens to the gases—whether the deoxidizer combines with them and fluxes them off, whether they are given off as gas wholly or in part, or whether addition of the deoxidizer merely enables the metal to hold more gas in solution—these are important questions not yet adequately answered.

Second, considering a deoxidizer (ferro-alloy) with two or more reactive constituents (e.g., Mn: C, Al: Si,

Mn: Ti, Mn: Si: Ti alloys, the iron in the ferro-alloy being regarded as inert) in respect to its chemical action on solid oxide impurities in carbon steel, the following cases may arise:

a. The active elements in the deoxidizer may, and probably will, be consumed at unequal rates in reacting with the impurities—e.g., aluminum, being more reactive than manganese, may be consumed faster, hence

b. The deoxidation slags produced by such differential consumption of the deoxidizing element will vary correspondingly, and, in general, will be different for each different alloy of the same active elements.

c. For any given impurity a condition may be reached such that when the impurity has entirely consumed one of the active elements in the deoxidizer, there is no further action on what remains of the other active elements; these may then alloy with the steel.

d. The reaction products (deoxidation slags) will tend to free themselves from the metal bath in proportion to their fusibility, fluidity and insolubility in the molten metal, and in general these properties of the products will be different for each combination of deoxidizing elements.

e. The deoxidizer may not reduce or flux off completely the foreign oxides, some of which may remain in the bath.

f. Usually the deoxidation period is too short for the establishment of equilibrium in the physicochemical sense of the word.

Third, considering the deoxidizer in relation to its possible action on carbides, phosphides and sulphides, it can be seen that for each of these there are the same possibilities as for oxide impurities. It can also be seen that the deoxidizer may, and probably will, react to some extent with all classes of non-gaseous impurities at the same time, and that, accordingly, extremely complex chemical reactions may take place.

Fourth, considering the action of the deoxidizer with respect to variables of a physical nature as contrasted with the chemical variables heretofore discussed, it is evident that the mode of action of each deoxidizer and the resulting deoxidation products will be affected by such factors among others as:

a. Temperature of the molten steel.

b. The manner of adding the deoxidizer—whether molten or solid.

c. The amount of the deoxidizer added.

d. The time allowed for action of the deoxidizer.

e. The use of two or more deoxidizers successively added.

f. The concentration of the active element in the deoxidizer.

To summarize, it would seem that there is small possibility of obtaining with any reasonable expenditure of effort or time accurate and complete information concerning each individual deoxidizer in respect even

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of the few variables which have been mentioned. Consequently, it is necessary to consider various experimental short-cuts that will approximate to a complete solution.

VALUE OF INFORMATION ON FUSIBILITY

Conforming to this idea, it was suggested by Dr. H. M. Howe that one of the most important functions of the steel deoxidizer is removal of the solid oxides contaminating the molten metal, which removal is usually believed to be accomplished by the formation of deoxidation slags which fuse and float to the surface of the metal and are usually skimmed off or poured off before tapping. Accordingly, the most fusible deoxidation slags are the most desirable ones, and a simple way to select new deoxidizers would be to choose such alloys of the active deoxidizing chemical elements as would yield very fusible combinations of the oxides of these elements. Such fusible combinations of oxides could be found by experimentally determining the melting points of a series of mixtures of the oxides. Once the most fusible oxide combinations were found experimentally by such procedure the calculation of the composition of the corresponding deoxidizing alloy is simple.

It is recognized, of course, that this view of the mode of action of the deoxidizer is a simplified one, and that it leaves out of consideration many of the factors of possible or known influence. However, this investigation constitutes but the first phase of a more extended research which has been begun at the Bureau of Standards consisting of the following parts:

1. A systematic selection of some new deoxidizing alloys—the present investigation.
2. The selection or production of the most practicable of these alloys to manufacture.
3. The use of the selected alloys for making steel experimentally under a variety of conditions.
4. Physical and chemical tests of the steels so made to determine useful properties, and particularly the determination of the gas content of the steels before and after deoxidation.

ORGANIZATION AND PLAN OF THE RESEARCH

A committee composed of Henry M. Howe, R. B. Sosman of the Geophysical Laboratory and the author recommended to the National Research Council that it enlist the co-operation of certain research organizations. After some correspondence and many changes in personnel of the group, the melting points included herein were determined by the institutions noted below. After a suitable selection of co-operating laboratories had been made the results were obtained very promptly, but very serious delays were incurred on account of those laboratories which originally volunteered for the work failing, after several months' efforts, to produce results. These remarks are not made in any spirit of criticism of the laboratories which withdrew, but merely for the purpose of giving some information as to how a co-operative research of this character, involving several groups of workers, actually progressed.

After much consideration, it was decided to limit this work to oxides of the more commonly used deoxidizing elements—manganese, silicon, aluminum and titanium. On account of the large amount of labor which might otherwise be necessary, it was thought the work should be confined to binary and ternary systems. In order still further to limit the field these oxides were com-

bined according to an arbitrary plan, which, nevertheless, seems to represent the path along which possible new deoxidation practices might be developed. For this purpose it was assumed that the slags resulting from deoxidation would be of the following types: silicates, titanates and aluminates in the binary systems and silico-aluminates, alumino-silicates, alumino-titanates and titano-aluminates in the ternary systems.

The investigation of the system $Al_2O_3-SiO_2$ was omitted at the suggestion of Dr. Sosman, since work already done shows that combinations of these two oxides all melt above 1,500 deg. C. Experimental work on all mixtures of MnO and Al_2O_3 also showed them to melt above 1,500 deg. C.

While it would seem desirable to have ferrous oxide present in all the mixtures investigated, since it is always found in steel deoxidation slags, this was not done, because of the greater complexity which the investigation would then assume. It is believed, however, that the effects of such amounts of ferrous oxide as would probably be present in deoxidation slags would be in all cases to lower melting points, so that any desirable mixtures of low fusing point found by this investigation could be assumed to be still more desirable because of probable presence of ferrous oxide.

METHODS FOR DETERMINING THE MELTING POINTS

In general, it was thought that the choice of the method could be left to the laboratory doing the work, depending on its equipment in the way of furnaces, pyrometers, etc. It was, however, considered necessary that the melting point determinations should be made in a non-oxidizing atmosphere, since the deoxidizer in a steel bath usually does its work under such conditions. It was recommended by the committee that electrically heated furnaces be used, either of the vacuum type (Arsem) or furnaces which permit the circulation over the mixture of a non-oxidizing gas. Very convenient crucibles were devised for the work and were used by several of the laboratories. These were made of "Armco" iron, supplied by the American Rolling Mill Co., and were pressed out of this material in the thimble-manufacturing machines at the Scovill Mfg. Co.'s plant. The melting point of the "Armco" iron, on account of its freedom from impurities, approximates that of pure iron (1,530 deg. C.); it was thought that any slags melting higher than such crucibles would be of no value in the steel industry; consequently, if during an experiment the crucibles showed signs of fusion before the contents (oxide mixtures), the experiment was carried no further.

The mixtures were made at the Bureau of Standards from the following materials: As a source of manganese oxide, c.p. manganese carbonate was used, since this dissociates at the temperatures used to MnO and CO_2 . For the aluminum oxide c.p. calcined Al_2O_3 was used. For silica a good grade of quartz was ground to 200-mesh, digested for several hours with hydrochloric acid and then washed free of chlorides. For titanium oxide the best commercial grade of rutile concentrate carrying 97 per cent TiO_2 was used (3 per cent silica). In making the mixtures containing the TiO_2 , correction was made for the silica impurity.

These various substances were thoroughly dried and mixtures were then prepared by weighing the components and mingling them thoroughly by turning over several times on a sheet of paper with a large spatula;

after this they were passed through an 80-mesh sieve several times in order to insure a still more homogeneous mixture. Fifty-gram portions of each mixture were then placed in sealed manila envelopes and these were sent out by the National Research Council as directed. Many mixtures had to be returned to Washington and redistributed because of changes in the co-operators.

REFERENCE WORK AT BUREAU

As a check on the accuracy of the method used by each co-operating laboratory the melting point of one of the mixtures (No. 89, with 25 per cent Al_2O_3 , 20 per cent MnO and 55 per cent TiO_2 , melting point 1,370 deg. C.) was determined at the Bureau of Standards by R. G. Waltenberg, and portions of this were distributed to each co-operating laboratory, which reported its fusion point as determined by their method. The method used by the bureau for this determination was as follows:

The finely ground materials were moistened with water and molded into cylinders 1 cm. in diameter by 1.5 cm. long. These were air dried at least one day before use.

The melting points were determined by direct observation in an Arsem vacuum furnace.¹ The cylinders of oxide mixture were placed in "Armco" iron crucibles (these were scoured until free from internal surface oxide) and the latter placed in a magnesia holder supported on a graphite stand. The crucibles were placed slightly below the hottest part of the furnace so that any change in shape of the material was visible through the observation window of the Arsem furnace. The temperature was raised gradually until evidence of softening or melting appeared. Then the temperature was determined with an optical pyrometer. The melting point was taken as the temperature at which the material would flow. The gaseous pressure in the furnace was about 1 mm. mercury throughout the work. The mixtures contained manganese as carbonate from which carbon dioxide was liberated as the temperature was raised. Considerable shrinkage of the cylinders took place during this stage.

It was found that the temperature of initial softening was not much lower than the temperature at which the material would flow. This was verified by removing some of the samples from the furnace after heating just below and a little above the melting point. On one of the samples the melting point was determined on material which had previously been melted. This melting point did not differ materially from the first determination.

The method used by each co-operating laboratory is briefly described below.

General Electric Co., work in charge of W. E. Ruder: The method used was practically that employed at the Bureau of Standards in determining the melting point of the "standard mixture." Result, 1,370 to 1,380 deg. C.

Westinghouse Electric Co., work in charge of P. G. Nutting: The method used was that used at the Bureau of Standards. Result, 1,368 deg. C.

National Lamp Works of General Electric Co., work in charge of E. C. Bain: Cones of the materials shaped like standard pyrometric cones were heated electrically in a tungsten-wound furnace. Hydrogen was on the outside of the heated tube containing the cones and a

TABLE I. MANGANESE OXIDE: SILICA, AND MANGANESE OXIDE: TITANIUM OXIDE SERIES

Per Cent MnO	Melting Pt., Deg. C. MnO:SiO ₂ Mixtures	Melting Pt., Deg. C. MnO:TiO ₂ Mixtures
5	Above 1500	1320
10	Above 1500	1160
15	Above 1500	1250
20	Above 1500	1200
25	Above 1500	1250
30	Above 1500	1180
35	Above 1500	1150
40	Above 1500	1200
45	Above 1500	1300
50	1268	1280
55	1264	1350
60	1256	1420
65	1228	1425
70	1258	1457
75	1287	1420
80	1282	1455
85	1284	1485
90	Above 1500	Above 1500
95	Above 1500	Above 1500

TABLE II. MANGANESE OXIDE: SILICA: ALUMINA SERIES

Per Cent MnO	Per Cent SiO ₂	Per Cent Al ₂ O ₃	Melting Pt., Deg. C.
70	15	15	1245
60	25	15	1179
50	35	15	1138
40	45	15	1121
30	55	15	1145-1163
20	65	15	1435
60	15	25	1327
50	25	25	1223
40	35	25	1215
30	45	25	1149-1115-1124
20	55	25	1171
50	15	35	1448
40	25	35	1223
30	35	35	1138
20	45	35	1174-1163
40	15	45	1458
30	25	45	1286
20	35	45	1245
30	15	55	1494
20	25	55	1469-1477
20	15	65	1538

TABLE III. MANGANESE OXIDE: SILICA: TITANIUM OXIDE SERIES

Per Cent MnO	Per Cent SiO ₂	Per Cent TiO ₂	Melting Pt., Deg. C.
70	15	15	1260
60	15	25	1224
50	15	35	1154
40	15	45	1144
30	15	55	1187
20	15	65	1185
60	25	15	1170
50	25	25	1140
40	25	35	1190
30	25	45	1190
20	25	55	1160
50	35	15	1130-1160
40	35	25	1190-1200
30	35	35	1190-1200
20	35	45	Above 1500
40	45	15	1200-1180
30	45	25	Above 1500
20	45	35	Above 1500
30	55	15	Above 1500
20	55	25	Above 1500
20	65	15	Above 1500

TABLE IV. MANGANESE OXIDE: ALUMINA: TITANIUM OXIDE SERIES

Per Cent MnO	Per Cent Al ₂ O ₃	Per Cent TiO ₂	Melting Pt., Deg. C.
70	15	15	1388
60	15	25	1366
50	15	35	1329-1350
40	15	45	1320
30	15	55	1328
20	15	65	1354
60	25	15	1392
50	25	25	1403
40	25	35	1381
30	25	45	1348
20	25	55	1367
50	35	15	Above 1527
40	35	25	Above 1527
30	35	35	1428
20	35	45	1348
40	45	15	Above 1500
30	45	25	Above 1500
20	45	35	Above 144
30	55	15	Above 1500
20	55	25	Above 1500
70	65	15	Above 1500

current of nitrogen was passed through the interior of the tube. The cones were supported on alundum boats. The temperature observations were taken with a Holborn-Kurlbaum optical pyrometer. Result, 1,400 deg. C.

¹See Scientific Paper 212.

The Norton Co., Niagara Falls, N. Y., work in charge of R. H. White: A horizontal, electrically-heated carbon tube furnace was used. Cones of the material 1 in. high were placed in the uniform-temperature part of the tube, two or more cones for each mixture, and the melting point checked by two observers. Nitrogen was introduced into the furnace by a fused quartz tube extending within 6 in. of the cones. Temperatures were observed with a Leeds & Northrup optical pyrometer. Result, 1,406 deg. C.

The FitzGerald Laboratories, Niagara Falls, N. Y., work in charge of F. A. J. FitzGerald: Cones of the materials were placed near standard Seger cones in a carbon tube imbedded in granular carbon heated by an electric current. The point determined was where the oxide mixture softened and bent over completely. Result, 1,380 deg. C.

Bureau of Mines, Pittsburgh, Pa., work in charge of A. C. Fieldner: Cones of the material were tested by the gas furnace method for determining fusibility of coal ash, as described in Bureau of Mines Bulletin 129, pp. 111-114. Result 1,388 deg. C.

The accompanying tables give the results of the various determinations.

CONCLUSIONS

Seventy-three deoxidizing alloys, all of possible value to steel makers, have thus been shown to have melting points, when oxidized, somewhat below the melting point of pure iron—some of them considerably below. The relative or actual value of these can be determined by carrying out the other phases of the complete investigation mentioned in this paper.

The only basis this investigation furnishes for judging the relative merits of the deoxidizers is comparative fusing points of the slags. It may be expected that a deoxidizer which gives the deoxidation slag of lowest fusing point will be the best. Of the new oxidizers the most fusible are as follows:

Composition	Melting Point of Mixed Oxides Deg. C.
75 per cent Mn, 24 per cent Si	1228
41 per cent Mn, 59 per cent Ti	1160
49 per cent Mn, 18 per cent Ti, 33 per cent Si	1130
13 per cent Al, 52 per cent Mn, 35 per cent Si	1121
12 per cent Al, 47 per cent Mn, 41 per cent Ti	1320

Industrial Wastes in Relation to Water Supplies*

INDUSTRIAL pollution of water, like sewage pollution, is an unfortunate accompaniment of civilization. It is estimated that not less than 40 per cent of the population of the United States is supplied with water obtained from surface sources, and it is therefore evident that the preservation of the purity of the streams and lakes of the country is important. The effect of industrial wastes on public water supply is generally manifested in one or more of the following ways:

- (1) Disagreeable odors or tastes.
- (2) Foreign substances which make the water unsightly and unsuitable for use or else interfere with the proper functioning of the purification works.
- (3) Chemical substances in solution which, though not objectionable to the sight or taste, may cause actual damage to waterworks structure, render the water less fit for domestic or industrial use on account of hardness or other chemical properties and may or may not be detrimental to health.

Some of the instances of pollution having particular reference to the chemical industry are discussed. The more important are:

In recent years the increase of the byproduct coke works has added materially to the problems of water supply in those districts in which the works are located. The wastes vary in composition depending upon the process and the degree to which the products are worked up for the market. A complex group of substances referred to as "phenols" and its derivatives persist in the waste products from the works by reason of the relative solubility in water and give rise to the greatest offence to water supplies. Phenol will form substitution products with chlorine gas and calcium hypochlorite, in use generally for water sterilization, forming the intensely aromatic trichlorophenol.

The trouble arising from the wastes from wood distillation industries are more frequently those arising from the destructive distillation of hard woods, although

some trouble has been reported from plants using resinous wood. Spent still liquors and sludges, all of which have a penetrating odor and "smoky" taste peculiar to wood creosote, are the cause of most of the trouble. Unlike coal "phenols," the wood "phenols" are little affected by the chlorination process used in sterilization. No method has been found which is effective in removing objectionable tastes and odors caused by these substances.

The wastes from tanneries are objectionable from the fact that they cause additional expense in the proper purification of the water into which they are added as well as being unsightly.

The wastes from the paper and pulp industries have been the cause of litigation in those states where the waste from mills is run into streams.

It can hardly be denied that the prosperity of a nation is fairly measured by its industrial development. It is obvious therefore that the proper solution of the problem of industrial pollution does not lie in the forbidding of industry, but in a sane regulation whereby industries may flourish without detriment to the resources of the country. It is proper that the burden of preventing stream pollution should be placed on the industrial plants themselves. There has been too much carelessness by manufacturers in allowing obnoxious wastes to enter streams and too much disregard of the rights of the public, particularly in the use of streams. The manufacturers can often with little expense prevent the pollution of streams, and repeatedly it has been found that the unwilling adoption of a process for waste disposal has resulted in a clear profit to the manufacturer from the recovery of byproducts. On the other hand, it is apparent that the necessities of the public water supply have sometimes borne down rather heavily upon industries when remedies were at hand for offsetting the effects complained of. It must be admitted that water purification plants are very much stereotyped in design and fitted for handling the older problems of removing sewage effects. In this matter it would seem that "rule of reason" might often be put into effect, although it must be admitted that the structure of American law is not inclined much to the principle of "balance of conveniences."

*Abstract of a paper presented by Wellington Donaldson at the San Francisco meeting American Public Health Association.

Experiments in Manufacturing No. 12 Alloy

No. 12 Alloy May Be Conveniently and Economically Prepared by Charging Aluminum Ingot, No. 12 Ingot and Scrap and a Copper-Rich Alloy Into the Melting Furnace, and There Is No Advantage in Any Other Procedure

BY ROBERT J. ANDERSON*

FOR the purpose of securing comparative data with regard to the manufacture of light aluminum : copper alloys by the various methods in use, a number of experiments were carried out at the Gloekler Foundry Co., Pittsburgh, Pa. In these experiments No. 12 alloy heats were made up by the use of copper, 33:67 alloy, 50:50 alloy, and 60:40 alloy.

METHOD OF EXPERIMENT AND MATERIALS

In all of the experimental heats, the endeavor was made to keep the conditions the same so far as possible, and the variables included time, temperature, and method of introducing the copper. The various heats were melted in plumbago crucibles in a gas-fired melting furnace, and sand castings were poured from each heat. Chemical compositions of the materials employed are given in Table I. No. 12 alloy scrap was used in some of the heats so as to approximate foundry practice more closely. Pouring temperatures were taken with a Wilson-Maeulen "pyod." Table II gives a summary of the experiments, and they are described in detail below. Chemical analyses of some of the sand castings poured in the various heats are given in Table III. The initial temperature of the hot crucible into which the materials were charged was taken as 600 deg. C., but this was somewhat variable—that is to say, between 400 and 700 deg. C.

USE OF SOLID COPPER

In the experiments carried out in the preparation of No. 12 alloy by alloying solid copper and liquid aluminum, the aluminum was melted in the crucible, and the copper added later. Two experiments in particular were carried out in order to observe the effect of agitation. In experiment G-1 the copper was added and allowed to sink to the bottom; no stirring was done, and the metal was poured into castings after standing for 30.0 minutes. In experiment G-2, the copper was added as in experiment G-1, but the melt was thoroughly stirred every few minutes. The melt was held in the furnace for 30.0 minutes, and was again well stirred before pouring into castings. The detailed data are given below.

Experiment G-1. In this experiment solid copper was added to liquid aluminum without stirring.

Charged aluminum into a hot crucible at 600 deg., lb.	23.0
Time required to melt aluminum, min.	23.0
Gas consumption, cu.ft.	2,415
Temperature of the aluminum at the time copper was added, deg. C.	697
Charged copper, lb.	2.0
Highest observed temperature of the resultant alloy, deg. C.	765
Total gas consumption, cu.ft.	2,940
Final temperature, deg. C.	740
Pouring temperature of castings, deg. C.	732
Weight of ingots and castings poured, lb.	24.90
Weight of dross recovered, lb.	0.20
Shrinkage, lb.	+0.10
Loss due to oxidation and shrinkage, per cent.	0.40

Experiment G-2. Here, solid copper was added to liquid aluminum with thorough stirring.

Charged aluminum into a hot crucible at 600 deg. C., lb.	23.0
Time required to melt the aluminum, min.	28.0
Gas consumption, cu.ft.	2,940
Temperature of the aluminum at the time copper was added, deg. C.	685
Charged copper, lb.	2.0
Highest observed temperature of the resultant alloy, deg. C.	765
Total gas consumption, cu.ft.	3,465
Final temperature, deg. C.	750
Pouring temperature of castings, deg. C.	744
Weight of castings and ingots poured, lb.	24.70
Weight of dross recovered, lb.	0.20
Shrinkage, lb.	0.20
Loss due to oxidation and shrinkage, per cent.	1.20

Some additional foundry experiments were made in the preparation of No. 12 alloy by adding copper directly. In one experiment, the copper was melted first and the aluminum added later; in the other, the aluminum was melted first and the copper added later, but the temperature of the aluminum in this experiment was considerably higher than was the temperature in experiments G-1 and G-2. These additional experiments are described below.

Experiment G-3. In this experiment, the copper was melted first and the aluminum added later.

Charged copper into a hot crucible at 600 deg. C., lb.	2.0
Time required to melt the copper, min.	23.0
Gas consumption, cu.ft.	2,415
Temperature of the copper at the time the first aluminum addition was made, deg. C.	1,128
Charged aluminum in small amounts every few minutes during 35 minutes, lb.	23.0
Highest observed temperature, deg. C.	1,195
Total gas consumption, cu.ft.	4,515
Final temperature, deg. C.	754
Pouring temperature of castings, deg. C.	710
Weight of castings and ingots poured, lb.	24.50
Weight of dross recovered, lb.	0.50
Shrinkage, lb.	0.00
Loss due to oxidation and shrinkage, per cent.	2.00

TABLE I. CHEMICAL ANALYSES OF THE MATERIALS USED IN PREPARING No. 12 ALLOY

Material	Elements, per Cent			
	Cu	Fe	Si	Al(a)
Aluminum	0.25	0.39	0.31	99.05
Light copper (b)	99.89	...	...	...
Heavy copper (b)	99.92	...	...	...
33:67 alloy	33.05	0.50	0.36	66.09
50:50 alloy	49.24	0.49	0.35	49.92
60:40 alloy	59.29	0.53	0.32	39.86
No. 12 alloy	8.38	0.58	0.41	90.63

(a) Aluminum, by difference.

(b) The light copper was used in experiments G-1, G-2, G-4, and the heavy copper in experiment G-3.

Experiment G-4. Here, aluminum was melted first and the copper added later.

Charged aluminum into a hot crucible at 600 deg. C., lb.	23.0
Time required to melt the aluminum, min.	31.0
Gas consumption, cu.ft.	3,255
Temperature of the aluminum at the time copper was added, deg. C.	715
Charged copper, lb.	2.0
Highest observed temperature of the resultant alloy, deg. C.	950
Total gas consumption, cu.ft.	3,780
Final temperature, deg. C.	928
Pouring temperature of castings, deg. C.	720
Weight of castings and ingots poured, lb.	24.75
Weight of dross recovered, lb.	0.35
Shrinkage, lb.	+0.10
Loss due to oxidation and shrinkage, per cent.	1.00

USE OF 33:67 COPPER:ALUMINUM ALLOY

Heats of No. 12 alloy were made up by using the 33:67 alloy for introducing the copper. In foundry

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practice, it is customary to charge the rich alloy and the aluminum ingot plus No. 12 scrap at once, and the whole charge is presumed to go down at once. As a matter of fact, the rich alloy, whether 33:67 or 50:50, melts first and the aluminum later. In making up No. 12 heats by the use of a rich alloy, it is possible to do this in at least three ways: (1) By charging the rich alloy and the aluminum together; (2) by melting the aluminum first and then adding solid rich alloy; and (3) by melting the rich alloy first and then adding the aluminum later. Also the aluminum and the rich alloy might be melted separately and the one poured into the other. Practically, the two methods used commercially are (1) and (2) above, but data with regard to (3) are also presented for the sake of comparison.

Experiment H-1. In this experiment, the required amounts of rich alloy, aluminum and No. 12 scrap were charged together.

Charged aluminum into a hot crucible at 600 deg. C., lb.	9.47
Charged No. 12 scrap, lb.	12.50
Charged 33:67 alloy, lb.	3.03
Time required to melt the charge, min.	23.0
Gas consumption, cu.ft.	2,415
Highest observed temperature of the resultant alloy, deg. C.	700
Total gas consumption, cu.ft.	2,415
Final temperature, deg. C.	685
Pouring temperature of castings, deg. C.	672
Weight of castings and ingots poured, lb.	24.70
Weight of dross recovered, lb.	0.20
Shrinkage, lb.	0.10
Loss due to oxidation and shrinkage, per cent.	1.20

Experiment H-2. In this experiment, the aluminum plus No. 12 scrap was melted first, and the 33:67 alloy was then added to the liquid melt.

Charged aluminum into a hot crucible at 600 deg. C., lb.	9.47
Charged No. 12 scrap, lb.	12.50
Time required to melt this charge, min.	25.0
Gas consumption, cu.ft.	2,625
Temperature of the alloy at the time the 33:67 alloy was added, deg. C.	650
Charged 33:67 alloy, lb.	3.03
Time required for the rich alloy to go into solution, approximately, min.	1.0
Highest observed temperature of the resultant alloy, deg. C.	710
Total gas consumption, cu.ft.	3,150
Final temperature, deg. C.	710
Pouring temperature of castings, deg. C.	704
Weight of castings and ingots poured, lb.	24.85
Weight of dross recovered, lb.	0.15
Shrinkage, lb.	0.00
Loss due to oxidation and shrinkage, per cent.	0.60

Experiment H-3. The rich alloy was melted first in this experiment, and the aluminum was charged later. No scrap was used.

Charged 33:67 alloy into a hot crucible at 600 deg. C., lb.	6.06
Time required to melt the alloy, min.	12.0
Gas consumption, cu.ft.	1,260
Temperature of the alloy at the time the aluminum was added, deg. C.	649
Charged aluminum, lb.	18.94
Time required to melt the aluminum, min.	20.0
Highest observed temperature of the resultant alloy, deg. C.	720
Total gas consumption, cu.ft.	3,360
Final temperature, deg. C.	720
Pouring temperatures of castings, deg. C.	710
Weight of castings and ingots poured, lb.	24.60
Weight of dross recovered, lb.	0.30
Shrinkage, lb.	0.10
Loss due to oxidation and shrinkage, per cent.	1.60

50:50 COPPER:ALUMINUM ALLOY

A number of No. 12 alloy heats were made up where the 50:50 copper:aluminum was employed for introducing the copper. The methods were practically the same as in experiments H-1 to H-3 where the 33:67 alloy was used.

Experiment I-1. In this experiment, the required amounts of aluminum, No. 12 scrap, and rich alloy were charged together.

Charged aluminum into a hot crucible at 600 deg. C., lb.	10.5
Charged No. 12 scrap, lb.	12.5
Charged 50:50 alloy, lb.	2.0
Time required to melt the charge, min.	30.0
Gas consumption, cu.ft.	3,150
Highest observed temperature of the resultant alloy, deg. C.	730
Total gas consumption, cu.ft.	3,885
Final temperature, deg. C.	730
Pouring temperature of castings, deg. C.	711
Weight of castings and ingots poured, lb.	24.75
Weight of dross recovered, lb.	0.15
Shrinkage, lb.	0.10
Loss due to oxidation and shrinkage, per cent.	1.00

Experiment I-2. In this experiment, aluminum was melted first and 50:50 alloy was added to the liquid charge.

Charged aluminum into a hot crucible at 600 deg. C., lb.	21.0
Time required to melt the aluminum, min.	21.0
Gas consumption, cu.ft.	2,205
Temperature of the aluminum at the time the 50:50 alloy was added, deg. C.	690
Charged 50:50 alloy, lb.	4.0
Time required (approximately) for the 50:50 alloy to go into solution, min.	2.5
Highest observed temperature of the resultant alloy, deg. C.	780
Total gas consumption, cu.ft.	3,255
Final temperature, deg. C.	780
Pouring temperature of castings, deg. C.	710
Weight of castings and ingots poured, lb.	24.80
Weight of dross recovered, lb.	0.20
Shrinkage, lb.	0.00
Loss due to oxidation and shrinkage, per cent.	0.80

Experiment I-3. Here, the 50:50 alloy was melted first, and the aluminum ingot was added later.

Charged 50:50 alloy into a hot crucible at 600 deg. C., lb.	4.0
Time required to melt the alloy, min.	12.0
Gas consumption, cu.ft.	1,260
Temperature of the alloy at the time the aluminum was added, deg. C.	608
Charged aluminum, lb.	21.0
Time required to melt the aluminum, min.	18.0
Highest observed temperature of the resultant alloy, deg. C.	715
Total gas consumption, cu.ft.	3,675
Final temperature, deg. C.	715
Pouring temperature of the castings, deg. C.	706
Weight of castings and ingots poured, lb.	24.60
Weight of dross recovered, lb.	0.40
Shrinkage, lb.	0.00
Loss due to oxidation and shrinkage, per cent.	1.60

60:40 COPPER:ALUMINUM ALLOY

As has been mentioned previously, a 60:40 copper:aluminum alloy has not been used in the foundry, so far as is known, for introducing copper into aluminum. Since it is a brittle alloy and melts at approximately the same temperature as aluminum, it was thought to be worthy of trial. Accordingly, a number of heats were made up with this alloy.

Experiment J-1. The rich alloy, aluminum, and No. 12 scrap were melted together in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb.	10.84
Charged No. 12 scrap, lb.	12.50
Charged 60:40 alloy, lb.	1.66
Time required to melt this charge, min.	30.0
Gas consumption, cu.ft.	3,150
Highest observed temperature, deg. C.	715
Total gas consumption, cu.ft.	3,675
Final temperature, deg. C.	715
Pouring temperature of castings, deg. C.	711
Weight of castings and ingots poured, lb.	24.80
Weight of dross recovered, lb.	0.13
Shrinkage, lb.	0.05
Loss due to oxidation and shrinkage, per cent.	0.80

Experiment J-2. In this experiment, the aluminum and No. 12 alloy were melted first, and when liquid the proper addition of 60:40 alloy was made.

Charged aluminum into a hot crucible at 600 deg. C., lb.	10.84
Charged No. 12 scrap, lb.	12.50
Time required to melt this charge, min.	24.0
Gas consumption, cu.ft.	2,520
Temperature of this charge at the time the 60:40 addition was made, deg. C.	645
Charged 60:40 alloy, lb.	1.66
Highest observed temperature of the resultant alloy, deg. C.	709
Total gas consumption, cu.ft.	3,045
Final temperature, deg. C.	709
Pouring temperature of the castings, deg. C.	699
Weight of castings and ingots poured, lb.	24.90
Weight of dross recovered, lb.	0.20
Shrinkage, lb.	+0.10
Loss due to oxidation and shrinkage, per cent.	0.40

Experiment J-3. In this experiment, the 60:40 alloy was melted first, and the aluminum was added later. No scrap was used.

Charged 60:40 alloy into a hot crucible at 600 deg. C., lb.	3.32
Time required to melt the alloy, min.	10.0
Gas consumption, cu.ft.	1,050
Temperature of the alloy at the time the aluminum was added, deg. C.	700
Charged aluminum, lb.	21.68
Time required to melt the aluminum, min.	18.0
Highest observed temperature of the resultant alloy, deg. C.	707
Total gas consumption, cu.ft.	3,465
Final temperature, deg. C.	707
Pouring temperature of the castings, deg. C.	701
Weight of castings and ingots poured, lb.	24.75
Weight of dross recovered, lb.	0.25
Shrinkage, lb.	0.00
Loss due to oxidation and shrinkage, per cent.	1.00

Experiment J-4. Aluminum and 60:40 alloy were melted together in this experiment.

Charged aluminum into a hot crucible at 600 deg. C., lb.	21.68
Charged 60:40 alloy, lb.	3.32
Time required to melt the charge, min.	26.0
Gas consumption, cu.ft.	2,730
Highest observed temperature, deg. C.	730
Total gas consumption, cu.ft.	3,465
Final temperature, deg. C.	730
Pouring temperature of castings, deg. C.	710
Weight of castings and ingots poured, lb.	24.80
Weight of dross recovered, lb.	0.30
Shrinkage, lb.	+0.10
Loss due to oxidation and shrinkage, per cent.	0.80

DISCUSSION OF THE EXPERIMENTS

An inspection of the experimental details and the summary in Table II affords interesting data from which conclusions may be safely drawn. Both dross losses and gas consumption are high in the experiments where either copper or the rich alloys were melted first and the aluminum added later. Both dross losses and gas consumption are low when the entire charge is melted at once, or where the necessary rich alloy (or copper) is added to a liquid bath. There appears to be no advantage gained by adding solid rich alloy or solid copper to liquid aluminum as compared to charging all the materials together. In general, the higher dross losses result from higher temperatures, for example in experiments G-3 and G-4. In experiment G-3 the copper was melted first, and when at a temperature of 1,128 deg. C. aluminum was introduced. In experiment G-4, the temperature of the alloy, after the copper addition, was purposely raised to 950 deg. C., and the dross loss was consequently high. But few apparent anomalies appear in the summarized data, and it will be readily apparent that these may exist without vitiating the results because of the conditions of the experiments. As already explained, the initial charging temperature of the hot crucible was arbitrarily taken as 600 deg. C., but this varied considerably, as shown by temperature measurements. Consequently, gas consumption figures vary, but within reasonable limits. The difficulty of collecting all of the melt, after pouring castings and ingots, and

the practical impossibility of cleaning the crucible so as to recover all of the dross and the alloy sticking to the inside will lead to minor errors. Where there is a plus shrinkage, the materials were recovered most completely; the weight of the castings and ingots poured plus the dross should give a total weight greater than the weight of the original charge because of the oxidation of aluminum to Al_2O_3 .

In considering the dross and shrinkage losses in Table II, it should be borne in mind that the experiments were carried out on a small scale, 25-lb. charges being used. The relative order of the losses in preparing No. 12 alloy by the different methods is correct, but the actual figures are too high for large-scale practice. Moreover, it should be pointed out that ordinarily the dross is not

TABLE III. CHEMICAL ANALYSES OF SOME OF THE CASTINGS
POURED IN THE NO. 12 ALLOY EXPERIMENTS

Experiment	Elements, per Cent			
	Cu	Fe	Si	Al (a)
G-1	7.47	0.49	0.33	91.71
G-2	7.66	0.48	0.40	91.46
H-1	9.29	0.61	0.38	90.72
H-2	8.19	0.54	0.38	90.89
I-1	8.23	0.48	0.44	90.85
I-3	8.13	0.42	0.38	91.07
J-1	7.92	0.62	0.42	91.04
J-2	7.94	0.58	0.40	91.08

(a) Aluminum, by difference.

entirely loss in commercial practice because a considerable recovery of metal would be made by running down the dross and skimmings. These matters should be borne in mind when considering the loss figures.

METALLOGRAPHY OF THE SAND CASTINGS

The castings poured from the No. 12 alloy heats described above consisted of thin shells and 1.0-in. square bars, following the practice in the writer's previous experiments on blowholes and unsoundness in aluminum-alloy castings.¹ In connection with the present experiments, microsections were cut from all of

¹Anderson, R. J., "Unsoundness in Aluminum-Alloy Castings," *The Foundry*, vol. 47, 1919, pp. 579-584.

TABLE II. SUMMARY OF THE NO. 12 ALLOY EXPERIMENTS

Experiment	Wt. Copper, Lb.	Wt. Al., Lb.	Wt. No. 12 Scrap, Lb.	Wt. Rich Alloy, Lb.	Temp. Initial Charge after Melt, deg. C. (b)	Highest Observed Temp., deg. C. (c)	Final Temp., deg. C.	Castings Poured at deg. C.	Wt. Castings and Ingots, Lb.	Wt. Dross Recovered, Lb.	Shrinkage, Lb.	Total Loss, per Cent	Metal Oxidized, per Cent (d)	Total Gas Consumption, Cu.Ft. (e)	Cost Gas Used, Dollars (f)	Remarks	Introduced Copper by Means of
G-1	2.00	23.00			697	765	740	732	24.90	0.20	+0.10	0.40	0.42	2,940	0.88	Solid copper added to liquid aluminum.	Copper
G-2	2.00	23.00			686	765	750	744	24.70	0.20	0.10	1.20	0.42	3,465	1.04	Solid copper added to liquid aluminum.	Copper
G-3	2.00	23.00			1,128	1,195	754	710	24.50	0.50	0.00	2.00	1.06	4,515	1.35	Copper melted first, and aluminum added later.	Copper
G-4	2.00	23.00			715	950	928	720	24.75	0.35	+0.10	1.00	0.74	3,780	1.13	Solid copper added to liquid aluminum.	Copper
H-1		9.47	12.50	3.03		700	685	672	24.70	0.20	0.10	1.20	0.42	2,415	0.72	Aluminum, No. 12 alloy and 33:67 alloy melted together.	33:67 alloy
H-2		9.47	12.50	3.03	650	710	710	704	24.85	0.15	0.00	0.60	0.32	3,150	0.95	Aluminum and No. 12 scrap melted first, and 33:67 alloy added later.	33:67 alloy
H-3		18.94		6.06	649	720	720	710	24.60	0.30	0.10	1.60	0.64	3,360	1.01	33:67 alloy melted first, and aluminum added later.	33:67 alloy
I-1		10.50	12.50	2.00		730	730	711	24.75	0.15	0.10	1.00	0.32	3,885	1.17	Aluminum, No. 12 alloy, and 50:50 alloy melted together.	50:50 alloy
I-2		21.00		4.00	690	780	780	710	24.80	0.20	0.00	0.80	0.42	3,255	0.98	Aluminum melted first, and 50:50 alloy added later.	50:50 alloy
I-3		21.00		4.00	608	715	715	706	24.60	0.40	0.00	1.60	0.84	3,675	1.10	50:50 alloy melted first, and aluminum added later.	50:50 alloy
J-1		10.84	12.50	1.66		715	715	711	24.80	0.15	0.05	0.80	0.32	3,675	1.10	Aluminum, No. 12 alloy and 60:40 alloy melted together.	60:40 alloy
J-2		10.84	12.50	1.66	645	709	709	699	24.90	0.20	+0.10	0.40	0.42	3,045	0.91	Aluminum and No. 12 alloy melted first and 60:40 alloy added later.	60:40 alloy
J-3		21.68		3.32	700	707	707	701	24.75	0.25	0.00	1.00	0.53	3,465	1.04	60:40 alloy melted first, and aluminum added later.	60:40 alloy
J-4		21.68		3.32		730	730	710	24.80	0.30	+0.10	0.80	0.64	3,465	1.04	Aluminum and 60:40 alloy melted together.	60:40 alloy

(a) See experimental details in the text.

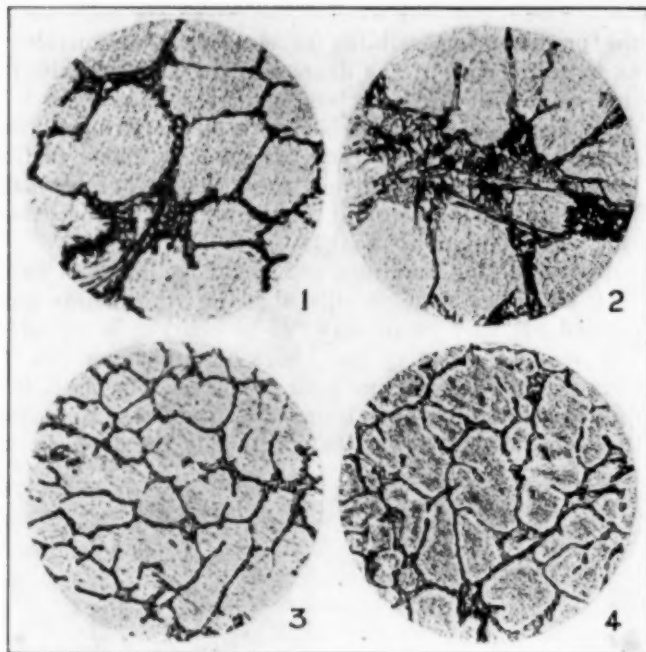
(b) The figures indicate the temperature of a liquid bath at the time of the addition of solid material. All solid additions were at room temperature.

(c) The figures indicate the observed highest temperatures; higher temperatures may have obtained, but they were not observed.

(d) Based on the assumption that dross is equivalent to Al_2O_3 , containing about 53.0 per cent aluminum.

(e) Furnace gas consumption was at the average rate of 105 cu.ft. per minute.

(f) Based on gas at \$0.30 per 1,000 cu.ft.



FIGS. 1 TO 4

Fig. 1. Microstructure of section cut from 1.0-in. square bar, cast in Experiment G-2. Fig. 2. Microstructure of section cut from 1.0-in. square bar, cast in Experiment I-3. Fig. 3. Microstructure of section cut from thin shell, cast in Experiment G-2. Fig. 4. Microstructure of section cut from thin shell, cast in Experiment I-3. All etched with NaOH $\times 135$.

the castings poured, and these were examined for general characteristics. Practically no differences with regard to microstructure (distribution of the CuAl_2 , etc.) were found, but blowholes and porosity appeared to be more numerous and greater in the case of castings poured from melts which, at one time or another during preparation, had attained rather high temperatures. Furthermore, these defects were more pronounced in the castings poured from heats where the dross losses were high, viz., G-3, J-3, and I-3. Typical microstructures of sections cut from the castings are shown in Figs. 1 to 4, inclusive.

GRADE OF NO. 12 ALLOY HEATS

In papers which have preceded this,² it has been shown that the 92 : 8 aluminum : copper alloy is prepared by various methods, and there remains to be considered, in a brief way, the various grades of heats used in making this alloy. Ordinarily, pig aluminum alone is not used, but some No. 12 ingot, or foundry scrap, or both, is added to the charge. The proportions of aluminum and No. 12 ingot or scrap in heats for castings may, and do, vary from 0 to 100 per cent. Where both aluminum and No. 12 ingot or scrap are charged, sufficient rich alloy, say 50 : 50, is charged at the same time for the purpose of introducing the desired amount of copper. In foundry practice, it is economical, and usually necessary, to charge some No. 12 alloy with the aluminum; the No. 12 scrap charged will be made up of gates, risers, and defective castings from the foundry. Furthermore, if the castings are machined in a shop in conjunction with the foundry, large amounts of No. 12 borings will accumulate, and these must be disposed of. Also, some foundries buy back the borings from their castings in case the castings are sold to outside consumers. The petroleum involved in the economical han-

dling of borings is one which is solved in different ways. Some foundries send the borings to outside refiners or smelters; the refiner will run the borings into No. 12 ingot, and return the resultant ingot for a fee. This ingot is then charged into the melting pots with the aluminum and the rich alloy. Other foundries run down the borings into ingot themselves, while a few charge borings as such into the pots; the latter practice has largely disappeared. The handling of borings has already been dealt with by Gillett and James.³

In some places, no attempt is made to preserve uniformity in the matter of relative percentages in successive heats, while in other foundries this is guarded closely. One foundry, for example, uses the following charge: 25 per cent No. 12 scrap (gates, risers, defective and broken castings), 25 per cent No. 12 ingot (run down from borings), 50 per cent aluminum ingot (plus sufficient 50 : 50 rich alloy). This charge is used continually unless the scrap losses on the floor mount to unusually high figures, and it becomes necessary to work more of the defectives into the charges.

The kind and quality of the scrap and No. 12 ingot used in foundry charges should be carefully controlled, since much difficulty may arise otherwise. Under Bureau of Aircraft Production specifications for Liberty (and other) motor castings, no No. 12 scrap other than that originating in the manufacturer's plant was allowed in the make-up of charges. The influence of the quality of the melting charge upon the resultant castings is one which is important and interesting to foundrymen, but it cannot be dealt with in this paper.

SUMMARY

The conclusions arrived at from the experiments and foundry experience in the preparation of No. 12 alloy by various methods are these:

First, there is nothing which would lead to the belief that one rich alloy is any better than another, for introducing copper, from the standpoint of dross losses and gas consumption.

Second, small heats of No. 12 alloy may be made conveniently and cheaply by using light gage copper sheet or punchings; the solid copper should be added to the liquid aluminum, whereupon it will alloy at relatively low temperatures.

Third, where the production is large, as in a foundry pouring 25,000 to 50,000 lb. of castings in eight hours, it is safer to employ a rich alloy.

Fourth, the most convenient rich alloy available (taking into consideration brittleness, melting point, and ease of calculation) is the 50 : 50 alloy.

Fifth, the most desirable method of making up a heat is to charge all the materials together.

Those foundrymen who hold to the belief that the "most desirable" method of preparing No. 12 alloy is by adding light copper punchings or sheet to liquid aluminum base their arguments largely on the saving arising in not using a rich alloy. The objection has been made that with this method the resultant castings are likely to run "hard" and "soft." The objection is valid, but, as has been shown, this may be overcome provided the melts are thoroughly stirred. Segregation of the CuAl_2 is extremely likely when melts are made by this method unless stirring is performed thoroughly and often. "Hard" and "soft" castings are attributed to

²"Foundry Methods for Light Aluminum: Copper Alloys," by Robert J. Anderson, *CHEM. & MET. ENG.*, vol. 23, No. 15, p. 735, Oct. 13, 1920.

³Gillett, H. W., and James, G. M., "Melting Aluminum Chips," *Bull. 108, Mineral Technology 14, Bureau of Mines, 1916.*

the fact that the first pour is lean in copper and the last relatively rich. This defect in the method is so serious that it renders the whole scheme undesirable in large foundries, particularly when the production is rushed. Danger of segregation will be greatly minimized if rich alloys are used for introducing the copper. Moreover, with unskilled labor at the melting pots, it is much safer to use a rich alloy. Further than that, there have been difficulties experienced, at times, by some foundries in obtaining a suitable and sufficient supply of copper. It appears that a small foundry can use the direct copper method to advantage, but a large foundry voluntarily puts fetters on itself when it adheres to this method solely. The No. 12 alloy may be conveniently and economically prepared by charging the aluminum ingot, No. 12 ingot and scrap, and rich alloy together into the melting furnace, and there is no advantage in any other procedure.

How to Paint Turpentine Tanks and Cars

Effective methods for painting the inside of turpentine tanks and tank cars have been described by specialists of the Bureau of Chemistry, United States Department of Agriculture, as follows:

When in contact with iron for any length of time, especially if the tank is only partly full, turpentine gradually turns yellow. This is due to the fact that on exposure to air, turpentine slowly absorbs oxygen and becomes slightly acid, causing corrosion of the iron, which goes into solution, causing the formation of the yellow or brown color.

Unless the iron is protected against the action of the acids formed when the tank has been emptied, and is full of air with a thin film of turpentine on the inner surface, tank cars in regular use for transporting turpentine soon become rusty inside. As ordinary paint, made from linseed oil and turpentine, will not resist the solvent action of turpentine, it is necessary to use a paint made from materials which are not affected by turpentine. One made according to the following formula, which makes about 8 gal., enough to give an 8,000-gal. tank two coats, is generally used for this purpose:

Methanol or denatured alcohol, gal.....	5
Orange shellac (pure), lb.....	24
Dry red lead, lb.....	24
Venice turpentine, oz.....	28

Dissolve the shellac in the alcohol. This operation, which takes some little time, is best done by putting the two in a can and allowing the mixture to stand, covered, for two or three days, stirring occasionally. After all the shellac has gone into solution, strain the liquid through cheese-cloth to remove any insoluble matter. Then warm the Venice turpentine until it flows freely and stir it into the shellac solution. This is now ready for use in making up the paint. When ready to use the paint, immediately before it is to be applied to the tank, from which all loose rust has been scraped or removed with a wire brush, mix the red lead with the liquid, being sure to stir thoroughly to break up all lumps. Apply with an ordinary paint brush to the thoroughly clean and dry surface. Brush the paint out well to prevent peeling. Allow the first coat to dry hard before applying the second coat.

When painting the inside of a tank with this preparation, or whenever it is necessary for a man to enter a tank which has held turpentine, some arrangement must be made to prevent inhalation of the alcohol or

turpentine fumes. A supply of fresh air can be pumped in to the workman through a pipe connected with either an air pump or a small blower like those connected with small portable forges. A gas mask with a container filled with broken pumice stone saturated with concentrated sulphuric acid, through which the air is drawn, may also be used. The absorption chamber must be recharged at least once a day. The pumice, in pieces about the size of a pea, should be steeped in the acid and the excess acid allowed to drain off before being placed in the container. Since concentrated sulphuric acid rapidly absorbs moisture from the air, thus losing its absorptive qualities, the acid supply and the pumice after saturation with the acid must not be exposed to the air any longer than absolutely necessary. A man should not remain in such a tank for more than four hours a day, and should come out sooner if he begins to feel unsteady, or if the muscles become "jerky." Continued work, day after day, in a tank with a methanol paint should be avoided, as the poisonous effects of methanol are cumulative.

Sugar Industry in Brazil

Every state in Brazil produces sugar cane. Reliable statistics, however, are not obtainable, as most of the production is for local consumption, reports Consul-General Haeberle of Rio Janiero. Moderate estimates give the approximate number of bags of sugar produced as follows in 1911, 1914 and 1917: 1911-12, 5,000,000 bags of 60 kilos (132 lb. each bag); 1914-15, 5,196,000 bags; 1917-18, 7,350,000 bags. The States of Pernambuco, Sao Paulo, Sergipe and Bahia lead in the production of sugar in the order named.

The cane is all crushed in the country. In many places in the interior rudimentary appliances, made of hardwood, are still used to crush the cane. These establishments, producing dark-brown cake sugar ("rapadura"), consumed by the laborers on the farm, do not figure in any statistics, and the total production cannot be estimated. It is large, however. Small American crushers with three vertical steel cylinders are often used on farms and in small factories, driven by human or animal power. Some factories have up-to-date machinery; only one factory so far, however, has introduced the diffusion process in Brazil—the Uzina Esther, in Sao Paulo, with a daily capacity of 125 tons of cane.

Most of the production is used for consumption in Brazil; only the surplus is exported. Exports in the years 1914 to 1919, inclusive, were in the following quantities (one metric ton = 2,204.6 lb.):

Kinds	1914 Metric Tons	1915 Metric Tons	1916 Metric Tons	1917 Metric Tons	1918 Metric Tons	1919 Metric Tons
White sugar.....	1,365	2,833	31,201	98,179	94,720	(a)
Demerara.....	20,876	22,064	12,974	10,541	8,984	(a)
Brown sugar.....	9,619	34,178	9,650	22,789	11,930	(a)
Total.....	31,860	59,075	53,825	131,509	115,634	69,429

(a) Classification not yet available.

Sugar cane in Brazil is not an annual plant; it remains on the fields for several years. Seasons of planting and crushing are governed by weather conditions, wet or dry, varying greatly according to the districts. As a rule sugar cane is planted during the rainy season and crushed when the dry season sets in. These seasons differ widely in the various parts of Brazil.

Legal Notes

BY WELLINGTON GUSTIN

Some Pitfalls of Selling

A broker's right to his commissions is involved in the action of Eugene Suter, a New York broker, against the Farmers' Fertilizer Co., recently decided in the Supreme Court of Ohio. The company had employed the broker to negotiate a contract for the sale of sulphuric acid to be manufactured by the company, the company agreeing with the broker to pay a brokerage of 1 per cent of the amount of the price provided for in such contract, to be paid as payments of the price were received by the company. Under this agreement the broker negotiated a contract between the company and the Aetna Explosives Co., whereupon it was agreed that the defendant company should proceed with the erection of a plant for the manufacture of sulphuric acid and sell and deliver to the Aetna company 600 tons of acid per month, commencing about April, 1916, and continuing thereafter monthly for a period of twelve months, deliveries to be made at defendant's plant, the Aetna company agreeing to pay for the acid on delivery at the rate of \$27 per ton of 2,000 lb., f.o.b. defendant's works, Columbus, Ohio. The contract expressly provided that a brokerage of 1 per cent on this sale should be paid by defendant company to the broker as payments were received. The defendant company erected its sulphuric acid plant and made various deliveries to the Aetna company between April and July, 1916, and paid brokerage thereon.

CLIENTS MAKE NEW AGREEMENT

However, in October, the defendant company entered into a contract with the Aetna company canceling the former contract and releasing the latter company from the obligations thereof in consideration of the payment by the Aetna company of \$45,000 and an agreement on the part of the Aetna company to repay any brokerage the defendant company might be compelled to pay beyond that admitted due on the \$45,000 cash settlement. Thereupon the broker was sent check for \$450, but this settlement was rejected by him, and this suit was brought to collect 1 per cent brokerage on the full amount of the original contract.

The defendant company contended that according to custom and usage among brokers in New York the plaintiff was entitled to commission or brokerage only upon the moneys received by the defendant under the original contract, and that the broker had been paid his full commissions on the moneys received under said contract.

INSOLVENCY OF BUYER SET UP AS DEFENSE

Further the defendant company claimed that shortly after it began shipping acid disputes arose with the Aetna company over the contract; that the latter failed to furnish cars for shipments as provided in the contract and refused to pay for the acid delivered; that the Aetna company became financially embarrassed, and in order to save itself and the broker from great loss on acid shipped and not paid for it entered into the cash settlement; that it made every effort to perform

the conditions of the contract on its part, but was prevented solely through the failure of the Aetna company and by its threatened and actual insolvency. Then the defendant company denied that it employed the broker to negotiate the contract with the Aetna company.

Upon hearing the evidence the jury was instructed to find a verdict for the defendant, Farmers' Fertilizer Co., and from a judgment against him Suter appealed. The Court of Appeals affirmed the trial court and a further appeal on error was made to the Ohio Supreme Court.

The first question decided was whether the broker had a valid contract of employment. The broker testified that he was employed by Young, general manager of the defendant. The president of the company denied that the general manager had any authority to make such a contract. But there were a number of telegraphic communications between the broker and defendant company on the subject, and thereafter the general manager entered into a written contract with the Aetna company for the sale of the acid. In this contract brokerage is expressly provided to be paid Suter. This contract was signed by the names of the two companies, and thereafter the company ratified this contract made by its general manager by entering upon its performance and by paying Suter certain commissions in accordance with its terms.

RIGHT TO COMMISSION RESTS ON CONTRACT

The Supreme Court said that the right of a broker to recover commissions rests upon contract, express or implied. The burden is upon him to prove that his services were rendered under employment by the principal, or that the latter accepted his agency and his acts under circumstances showing that he knew the services were being rendered on his account and while the agent was relying on the principal's obligation to pay him. If the services are rendered without employment, express or implied, or as a mere volunteer and without acceptance under the circumstances stated, he cannot recover.

Also, where a principal enters into a written contract of sale with a purchaser produced by a broker, in which instrument the principal agrees to pay the broker a specific compensation on "this sale," such action amounts to an acceptance of the services of the broker and ratification of his previous employment, even though such previous employment was made by an officer or agent who was without authority to make it.

On the question of the release of the Aetna company by defendant the rule was stated that where the obligations arising under a contract have attached, and subsequent thereto one party, without the consent of the other, does some act or makes some new arrangement which prevents the carrying out of the contract according to its terms, he cannot avail himself of this conduct to avoid his liability to the other party.

It appeared that the defendant company entered into the contract with the purchaser relying on its own investigations and knowledge of the ability of the Aetna company to carry out the contract, and because it was satisfied with the purchaser procured by the broker. Under such circumstances the release of the Aetna company from further performance of the contract on its part for the consideration named would entitle the broker to the immediate payment of his commission. Therefore the judgment of the two lower courts was reversed and judgment was ordered to be entered for the broker.

German Chemical Industries*

THE peace treaty requires that Germany shall deliver to France, during each of three successive years, 30,000 tons of sulphate of ammonia, 35,000 tons of benzene and 50,000 tons of coal tar. The Reparation Commission reserved the right to one-half the supply of dyestuffs and chemico-pharmaceutical products on hand at the time of the signing of the treaty; also an amount up to one-fourth of the product up to Jan. 1, 1915. Now that a year has elapsed since these provisions became effective, it is of interest to read the German reports of company meetings, chambers of commerce summaries, and trade-journal reviews of conditions in the chemical industry.

The two general conclusions that may be drawn from this published material seem at first to be entirely contradictory. The introductory pages of every report and summary discuss the shortage in coal and raw materials, the closing of plants, the scarcity and high cost of labor and the poor transportation facilities. As a consequence, a very great scarcity of the finished product is reported so that orders cannot be filled. Some reports specifically mention the French deliveries as the occasion of the shortage on the market. The impression of industrial hardship that is conveyed in these opening paragraphs is, however, offset at the end of the same reports by the financial statements that record, almost without exception, the declaring of dividends largely in excess of those of 1918. The explanation of the discrepancy is of course to be found in the heavy foreign demand at the high prices of the last few months of 1919.

Below are given a few summaries from the German Annals of Economics and Statistics (April, 1920), from the *Journal* of the Berlin Chamber of Commerce, from trade journals and from company reports.

RESUMPTION OF CHEMICAL TRADE DEPENDENT UPON COAL SUPPLY

Resumption of trade in chemicals is dependent upon the supply of coal. Shortage in coal has brought a large part of the industry to a standstill, or at least has caused great shortage in production. If, now, a shortage of raw material is to follow, such deficiency in the supply of sulphuric acid, caustic soda, pyrites, tar, sugar and casein will itself be traceable to the scarcity of coal. The *Rhenisch-Westfalia Zeitung* for March 1 says some relief was obtained at the end of February by the delivery of American coal which had been ordered but was not until then available.

The chemical industry seems to be at a standstill. The chemico-pharmaceutical industry is in some respects in a better situation than in January, in other respects in a worse position. Dyestuffs have shown a brief revival because of the receipt of a moderate amount of coal.

The shellac industry also makes an encouraging report. Soap reports run from "bad" to "fair." Asphalt and tar products suffered from lack of raw material. Coking plants, producing tar, ammonium sulphate and benzene, report a freight scarcity; business was in other respects improved over a year ago. Ethereal oils were sluggish, but improving. Benzine and turpentine were not coming on the market. Weak

conditions prevailed in the sulphuric acid and fertilizer industries; in the case of the latter, shortage of materials made it impossible to satisfy the demand.

The chemical industry suffered heavily during the past year by reason of the shortage of coal, which became extraordinarily acute toward the end of the year, causing many industries to close. The shortage in other raw materials became more and more serious at the same time that the world demand for chemical products became so insistent. At this juncture many foreign countries put an embargo on the importation of German products. Finally the 25 and 50 per cent deliveries required in the peace treaty affected the chemical market seriously.

REPORT OF BERLIN CHAMBER OF COMMERCE

The report of Berlin Chamber of Commerce for 1920 states that the chemical industry and the trade in chemicals, raw materials and auxiliary products suffered in war time greater changes than most branches of industry. Germany was in normal times heavily dependent upon foreign countries in many matters of production and distribution; this field was entirely cut off by the war. A transformation of the whole industry was the only solution. The brilliant achievements of those who had the matter in hand are testified to in the manufacture of explosives and artificial nitrates.

Increase in salaries and in wages of operatives as well as ever-rising costs of coal and raw material resulted, of course, in continuous increases in costs, which were accentuated by the shortage in coal and transportation. The effect was felt all along the line; the selling price was a mere barometer of conditions. No relief may be expected until the rate of exchange and inflated values have been brought back to normal. The demand is good, indeed almost impossible to meet, and yet production cannot possibly be accelerated.

GOVERNMENT CONTROL—HEAVY DEMAND FOR MANY PRODUCTS

Government control of sulphuric acid and other basic products grew more rigid rather than more lax. The shortage of pyrites made it useless to attempt to meet the demand. The maximum prices were set higher and higher, but production was dependent upon more fundamental things than money.

Hydrochloric acid was released from control in March, 1919. After a few months' production conditions were such that sales could be made even in Scandinavia and Finland, so that business in this line may be said to have been good. There was also a heavy demand for Glauber's salts, a byproduct of hydrochloric; it was impossible to fill the demand in Scandinavia.

Liquid anhydrous ammonia was in great demand. The small production of ammonium carbonate never permitted market prices to be within reason. Raw material for ammonium sulphate was exceedingly scarce, and yet the maximum price was so low that manufacture was unprofitable. Nitrogen prices reached a business-profit level only toward the end of the year. The production of spirits of ammonia was obstructed at intervals, but it became profitable in time.

Potassium prices were raised again and again, but the demand was still so keen that production was worth while. Copper vitriol was in heavy demand, but speculation drove the prices to too high a point. There was also a strong market for citric acid, but the raw

*Prepared by the European Division, Bureau of Foreign and Domestic Commerce.

material could not be obtained in Italy. Wolfram, molybdenum and vanadium could be obtained only in very small quantities.

TRADE IN PAINTS AND DYES

The marketing of pigments and dyes was restricted in the early part of the year because of the revolution; later on conditions improved until it was even possible to export some to neutral countries. With the signing of peace, export to France, Belgium and Italy set in until pre-war figures were met, especially in Belgium and Italy. It is very agreeable to note that the French trade also promises to pick up. England is still holding off. America, once a favorite territory, is still closed to us, and it is doubtful whether after peace is ratified our export to that country can be built up again, since the dye industry is making such strides over there. Injuries as to the market in the Orient indicate that that trade is reviving. In general, it may be said that German pigments and dyes will hold their markets abroad.

The supply of coal, soda, sulphuric acid and chrome salts was so low that it was impossible to fill the orders that piled in at the end of the year. Then the 8-hr. day has become a vital obstacle, as it is impossible to put some of the manufactures on such a basis. Double shifts are no solution; overtime is prevented by the attitude of the workers' organizations, even though individuals are in favor of it. Except for these circumstances, we might be able to build up foreign credits as a means of procuring food.

PIGMENT AND DYE INDUSTRIES COMBINE

The pigment and dye industries have found it necessary to combine. The German "Bunt- und Mineralfarben Industrie" and the Union of German Dye Industries were formed. These organizations have justified their existence in arranging for allocation of raw materials and the establishing of fixed prices, putting an end to profiteering. Goods for foreign sale were put at a higher price, so as to equalize the low rate of exchange. Prices are now about the same for all consumers. Altogether, the dye industries are in a favorable situation, except for the shortage of coal and raw materials.

The lac and varnish industry had a heavier demand than in 1918, but could not meet this demand, as the 8-hr. day and scarcity of material prevailed almost throughout the year. In December the restrictions on copal, shellac, rosin and turpentine oil were removed; linseed oil is still under control.

Production is still behind the average of former years. Increased production could hardly be hoped for, in the face of the restriction on the importation of benzene. The industry suffered by reason of the allocation of the raw materials to organizations outside of the trade.

GLUE, ETC.—DRUGS AND HERBS

The bone-glue production has been about 50 per cent. Foreign glues rose to impossible figures.

Mineral oils and tar products are on a 30 to 40 per cent production basis. There was a ready sale at home. Export was forbidden.

The drug industry suffered excessively under a shortage of materials. Coal was scarce and operatives were in an unsettled state. In the fall a general strike threw the whole trade into disorder. The retail business had been bad enough during the war; last year conditions

were hopelessly bad. Small factories were forced to shut down. Even for medicine and science very little was obtainable. Outside interests got such control that profiteering was inevitable. The general public suffered as a consequence.

Medicinal herbs could not be obtained, as the women and children who formerly gathered them were employed in factories at higher pay. Herbs rotted in the fields and woods; prices rose to ten—even fifty—times their former level.

REPORTS OF GERMAN CHEMICAL COMPANIES

The Chemische Fabrik Griesheim-Elektron, of Frankfurt, declared in 1919 a dividend of 12 per cent, as contrasted with 7 per cent in 1918—and this after setting aside over 4,000,000 marks for depreciation. This company explains the profits as arising from increased value of pre-war stocks. The Chemische Fabriken of Urdingen explain similar profits through the sale of stock held abroad. The Aktien Gesellschaft für Anilinfabrikation ("Agfa"), of Berlin, reports gross profits of 24,877,000 marks in 1919, as compared with 13,700,000 marks in 1918, warranting a dividend of 18 per cent. The Badische Anilin und Sodafabrik closed its works at Ludwigshafen and Oppau in November because of shortage of coal; the nitrogen works at Merseburg shut down because of political disturbances. In all these cases only a fraction of full production was reached by June, 1919, and yet the firms report large profits by reason of the great rise in prices of dyestuffs. Over 60,000,000 marks were written off, and yet the firm declared net profits of nearly 30,000,000 marks, justifying a dividend of 18 per cent.

The Farbwerke, of Höchst-am-Main, report that manufacturing was largely at a standstill during 1919 and early in 1920, only the pharmaceutical departments producing normally. But here, too, export sales enabled the company to declare a 14 per cent dividend, as contrasted with 12 per cent in 1918, on a basis of net profits of nearly 25,000,000 marks, even after deduction of an extra expense of 80,000,000 marks in increased wages. The gross profits of the Chemische Fabrik Rhenania, of Aix-la-Chapelle, advanced from 1,938,000 marks in 1918 to 5,723,000 marks last year. The dividend was increased from 10 to 25 per cent. Kalle & Co., of Biebrich, reported that only a part of the more important departments were operating, and yet, after deductions for depreciation, the dividend was increased from 7 to 14 per cent. The report is pessimistic as to prospects for 1920.

PRICES OF FERTILIZER FOR SEVEN YEARS COMPARED

Some idea of this general rise in value may be gained from the following comparative table of fertilizer prices (kilo = 2.2046 lb.):

Fertilizers	Price per Kilo, Marks						
	1913	1914	1915	1916	1917	1918	1919
Thomas slag, phosphoric:							
Spring.....	3.84	3.92	4.56	3.28	5.76	6.33	8.96
Fall.....	4.00	4.08	4.80	5.76	5.76	6.33	18.72
Kainit, 12 per cent pure potassium:							
Spring.....	1.20	1.20	1.20	1.88	1.56	2.16	3.12
Fall.....	1.20	1.20	1.20	1.56	2.16	2.76	4.92
Potash, 40 per cent pure:							
Spring.....	6.20	6.20	6.20	6.80	8.20	.....	16.40
Fall.....	6.20	6.20	.....	8.20	10.20	14.00	26.80
Ground calcium carbonate.....	.80	.80	.80	1.05	1.20	1.80	3.35
Lime.....	1.85	1.85	1.85	2.40	4.15	5.00	9.50
Ammonium sulphate.....	14.00	13.50	23.80	29.60	29.60	29.60	78.00
Calcium nitrate, 60 per cent.....	9.35	14.00	22.80	28.00	28.00	34.00	68.00
Ammonium superphosphate.....	.....	.....	.....	.....	15.40	16.70	43.50
Superphosphate, 10 per cent phosphoric.....	3.83	3.54	4.85	9.75	9.80	17.80	41.00
Rhenania phosphate.....	.....	.....	.....	6.60	6.60	10.15	27.75

Synopsis of Recent Chemical & Metallurgical Literature

Developing France's Natural Water Power. —

France's natural water power, known familiarly as the "houille blanche," continues to provide one of the most fascinating economic topics, now that the coal problem has become so difficult. About a year ago a committee, designated as the Commission des Forces Hydrauliques, was created officially, its duties being to investigate the water forces of France and establish a plan for the development of hydro-electric power plants. This committee recently rendered its report, which, as far as statistics go, is optimistic.

In round figures, the water power in France may be reckoned theoretically at about 9,000,000 hp. Of this amount, 1,165,000 hp. is in use. About 500,000 hp. additional is being equipped. Inside of fifteen years 3,000,000 more hp. should be realized. The rest remains available for eventual development. The 1,165,000 hp. now installed is capable of 850,000 kw. It furnished in 1919 effectively 700,000 hp. (570,000 kw.). The plants in course of construction will provide an additional 550,000 hp. (365,000 kw.).

The region of the southeast of France is the best developed thus far, with 750,000 hp. already installed, and with 290,000 hp. in course of installation. The southwest has 210,000 hp. and will have 75,000 more in a short time. The central section has 140,000 hp. and will have 125,000 more. The eastern district accounts for 25,000 and 10,000.

Existing plans, if realized, are to provide the 3,000,000 hp. additional of the program inside the fifteen years as projected. Of this total, 1,200,000 hp. will be in the southeast, 500,000 in the southwest, 400,000 in the center, 62,000 in the east. According to these figures, France then will stand in third place for water power among leading countries.

The United States is rated as having 30,000,000 hp., Canada 25,000,000, Norway 7,500,000, Sweden 6,750,000, Austria-Hungary 6,450,000, Italy and Spain about 5,500,000 each. Germany's water power is estimated at only 1,500,000 hp., and that of England at about 1,000,000 hp., but these two countries are richly compensated in coal.

Previous to the war the amount of capital invested in France's hydro-electric power plants was about 700,000,000 francs, of which 525,000,000 francs represented motive power and electricity, 100,000,000 francs for electrochemistry and electrometallurgy, and the remainder in traction enterprises. The preceding figures apply only to the important exploitations, and, as many smaller industries also are utilizing water power, it is safe to add at least 300,000,000 francs more to the total, so that about a billion francs is the figure for the global investment in the "houille blanche" in France at present. Or, if account is taken of the expenditures necessitated by the 500,000 hp. placed in operation during the war, the total investment is considerably more.

During this post-war period of high prices for material of all kinds, it is found that the cost prices for installations, which before the war varied between 500 and 800 francs per horsepower, have risen to a figure

between 1,000 and 1,600 francs. It is computed that, for putting into operation 3,000,000 hp., the expense must be calculated at three or four billion francs.

The official report suggests that, in the forming of concessionary companies, the government could participate as stockholder and thus be a party to profit or loss. The opinion is given that new companies should be exempted from taxes during the first five years.

The importance of the question of developing France's water power resources is shown in the simple equation: 8 millions of horsepower are equivalent to 40 million tons of coal.—*The Review*, Am. Chamber of Commerce, France, Sept. 1, 1920.

Influence of Manganese Content on the Life of Steel Ingot Molds.—Steel works and foundries commonly employ for casting of ingot molds an iron analyzing:

	Per Cent
Silicon	1.75 to 2.0
Manganese	0.4 to 0.6
Phosphorus, less than	0.15
Sulphur, less than	0.10
Carbon	3.5 to 4.0

Manganese was limited to 0.6 per cent in the belief that with a higher percentage the molds would crack after a very limited number of pourings.

Tests made by M. GROSCLAUDE (*Génie Civil*, Sept. 4, 1920, pp. 198, 199), covering a period of many years,

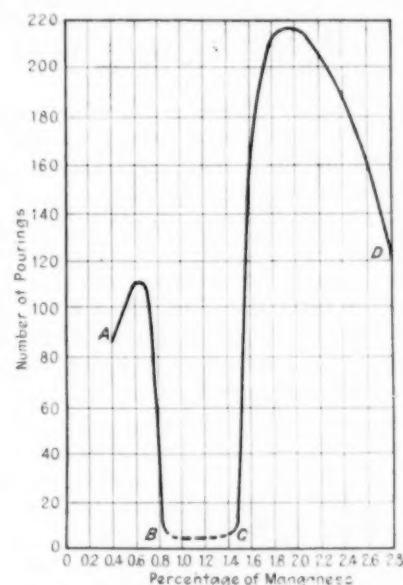


DIAGRAM SHOWING THE RELATION BETWEEN LIFE AND MANGANESE CONTENT IN INGOT MOLDS

have proved that an increase of manganese on the contrary lengthens the life of the molds. Thus, with ingot molds of the above composition the maximum number of pourings was 110, whereas as many as 250 were made with molds of the following composition:

	Per Cent
Silicon	1.5 to 1.8
Manganese	1.75 to 2.25
Phosphorus, less than	0.10
Sulphur, less than	0.05
Carbon	3.25 to 3.50

The average obtained with molds of this composition during two consecutive years was 175 pourings, with a minimum of 125.

The results of the tests are plotted in the accompanying figure, by which it is seen that the manganese content has a great influence on the life of the mold. No tests have been made with analyses between the points B and C.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Flameless Powder.—OSWALD SILBERRAD of Buckhurst Hill, England, has made a study of the conditions necessary for the production of propellant explosives which shall be flameless and smokeless when fired in guns of a specified size. An increase in the ratio of H-C-OH groups to NO₂ groups has been found to give the desired result. By the application of thermodynamics and internal ballistics it is possible to calculate the amount of carbohydrate material (preferably starch) which must be added to an ordinary propellant explosive in order to reduce the temperature of the gases emitted from the muzzle below the ignition point. The amount of starch to be added to 100 parts of propellant varies from 7 parts in the case of American pyrocollodion to 33 parts for Italian ballistite. Tables are given to facilitate calculations and proper methods of incorporating the starch are also discussed. (1,349,983; Aug. 17, 1920.)

Electrolytic Chlorate Cell.—The cathode of this cell consists of a shell or casing of metal such as cast iron. Interior partitions terminating below the rim of the casing divide the cell into several compartments. These partitions are connected with the casing so that they also serve as cathodes. A carbon anode is placed in each compartment and kept at a fixed short distance from the cathode by means of slate insulators. A porous asbestos cloth covers the cathode surface so that the hydrogen liberated is enabled to escape to the atmosphere without exerting any reducing influence on the electrolyte. An insulating plate of glass is placed in the bottom of each compartment to prevent short-circuiting due to the accumulation of conductive sediment. It is well known that in a cell of this type anode consumption is high when carbon is used as anode material. By making the compartments of different sizes, EDWARD A. ALLEN of Portland, Me., is able to use efficiently anodes which have been reduced in size by oxidation. Thus, the first compartment may be designed to take anodes 2 in. thick, the second 1½ in. and the third 1 in. Provision is also made for change in width of the anodes. (1,351,886; Sept. 7, 1920.)

Electrolytic Detinning Process.—The apparatus comprises a fixed vat for the electrolyte and a rotating hexagonal drum which is divided into longitudinal compartments by cathode plates projecting internally. The scrap which serves as anode material is placed in a removable permeable lining in each compartment. Insulators prevent contact between cathode and anode. (1,353,194, CECIL M. WALTER of Four Oaks, near Birmingham, England; Sept. 21, 1920.)

Ferrochromium.—Ferrochromium was formerly made to some extent in the iron blast furnace, but it was found that the limiting percentage of chromium which could be introduced into the alloy in the blast furnace was about 30 per cent. The most desirable commercial alloy contains about 60 per cent chromium. The

late JOSEPH E. JOHNSON, Jr., found that by enriching the blast with oxygen the temperature in the hearth could be raised sufficiently to produce alloys high in chromium and low in both carbon and silicon. A blast containing 40 to 50 per cent oxygen is suitable for this purpose. (1,354,491; Oct. 5, 1920.)

Magnesium Powder.—At the present time, the method used in manufacturing magnesium powder is to cast the magnesium into bars or ingots, which are reduced to powder by sawing, turning or milling. The cuttings produced are classified by screening, those too large for use being ground in some form of mill to reduce them to the proper size. This method requires a large and costly plant, and a very considerable outlay for labor to attend the large number of machines. The process is very slow and tedious, owing both to its nature and to the constant necessity of starting new cuts, replacing pieces of metal which are too short to be further treated, and re-casting the remnants into suitable shape. The large number of machines in motion and the difficulty of collecting the fine powder makes the plant an extremely dangerous one, as friction may at any time ignite the fine powder. Another of the disadvantages of this method is the difficulty of melting magnesium without considerable loss, so that the constant melting and re-melting of the metal to utilize the stubs of bars multiplies this loss. The product resulting from this method is far from satisfactory. Even after careful screening, the grains are not of uniform size, owing to their very irregular shape. When examined microscopically, the grains are found to be in the form of chips or shavings presenting knife edges which cause the grains to cling together, and also present a large amount of surface for oxidation. These characteristics of the powder render it unstable and difficult to deal with in certain applications. DAVID F. NICOL of Montreal, Canada, has found that powdered magnesium can be more conveniently prepared in the following manner: Magnesium is melted under a flux of lithium chloride in a closed vessel. The molten metal is discharged in a fine stream into a jet of nitrogen having sufficient velocity to break up the stream of metal into fine particles. The metal is chilled so rapidly by the cold nitrogen that practically no nitride is formed. (1,351,865; assigned to Shawinigan Electro-Metals Co.; Sept. 7, 1920.)

Bismuth Oxide.—Bismuth is a difficult metal to oxidize to produce lower oxides cheaply. By heating to fusion with an oxidizing agent such as sodium nitrate in the presence of chlorine, bismuth is rapidly converted into the yellow oxide Bi₂O₃. (1,354,806; ELTON R. DARLING of Montclair, N. J., assignor to Ellis-Foster Co.; Oct. 5, 1920.)

Aluminum Chloride.—In the manufacture of anhydrous aluminum chloride by the process of reducing bauxite or alumina in the presence of chlorine, it is necessary to supply heat to the mass to cause the reaction to proceed properly. Various expedients have been proposed but have not met with commercial success. FRANCIS C. FRARY of Oakmont, Pa., suggests the addition of aluminum to the mixture. The reaction between aluminum and chlorine is sufficiently exothermic to maintain the whole mass at the proper temperature. Aluminum dross containing about 40 per cent metallic aluminum forms an excellent raw material for this process. (1,354,818; assigned to Aluminum Co. of America; Oct. 5, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Rendering Non-Plastic Materials Plastic.—Small quantities of neutral or alkaline vegetable extracts are added with alkalis to clay or kaolin masses or non-plastic materials which are liquefied with difficulty by the addition of alkali alone. Neutral, water-soluble saponines or extracts of saponine-bearing plants such as seatwort, cookweed, sowbreads, ivy, chestnut-capsules are especially suitable. Alkaline cellulose-waste lyes and "cellular pitch" can also be used. (Br. Pat. 144,317—1919. A. WALTER, Frankfurt-on-Main, Germany, Aug. 5, 1920.)

Dyes From Natural Products.—Water-soluble dye preparations are obtained from animal or vegetable dye-yielding matters by extracting the raw material with organic solvents, evaporating the extract to a sirup or paste and fusing the product with a water-soluble metallic salt or solid organic acid. The same parent material may be extracted successively with more than one organic solvent, or first with organic solvent and then with water, to obtain different extracts for treatment. According to examples there are obtained a bluish-red dye for wool or silk by fusing an alcohol extract of cudbear with alum; a scarlet wool dye by fusing a pyridine extract of cochineal with cream of tartar; a reddish-mauve wool dye by fusing the same extract with alum; a blue wool dye by fusing an alcohol extract of turmeric with potassium ferricyanide; a navy-blue dye for wool or silk by fusing an alcohol extract of logwood with copper sulphate; a yellow or yellowish-red wool dye by fusing an alcohol extract of madder with alum; purple silk dyes by fusing an acetone or pyridine extract of madder with alum. Other specified materials are: As raw materials, Brazil wood or sanderswood; as solvent, amyl acetate; as fusion reagents, aluminum or ferric acetate, stannous chloride, potassium bichromate, or tartaric, citric, or oxalic acid. (Br. Pat. 144,336—1919. A. M. HART, London, Aug. 5, 1920.)

Removal of Cyanogen Compounds From Coal Gas.—Cyanogen compounds are removed from coal gas as calcium ferrocyanide by treating the gas in a lime purifier to remove sulphuretted hydrogen and carbonic acid, and then treating in the same purifier with slaked lime impregnated with a solution of salt of iron such as ferrous sulphate. The ferrous sulphate may be added to the lime in a tier of the lime purifier near the exit, and when the purifier is spent, the material from this tier is leached, or agitated with a dilute alkali to obtain alkali ferrocyanide. (Br. Pat. 144,398—1919. J. J. HOOD, London, Aug. 5, 1920.)

Separating Suspended Particles From Gases.—In the electrical separation of particles suspended in gases, the parasitic charges carried by freely moving nuclei, for instance nitrogen molecules, the formation of which lowers the efficiency of the precipitation process, are caused to deposit on sluggish particles in fine division and incorporated in the gases; these latter particles, which may be water, oil, etc., may be formed by condensation during the passage of the gas current, and may be either an addition to the gases or an original constituent. In the former case, the material may be added either in the liquid or vapor phases before the gases reach the dust-depositing chamber or in this chamber; and it may be introduced as a spray or may be taken up by the gases

in their passage through evaporating vessels or over moistened absorbent bodies. (Br. Pat. 144,701—1919. METALLBANK UND METALLURGISCHE GES., Frankfurt-on-Main, and J. E. LILIENFELD, Leipzig, Aug. 11, 1920.)

Welding Metal Sheets.—In a method of welding thin sheets or foils of aluminum or aluminum alloys—e.g., 0.005 to 0.100 mm. in thickness—to sheets of iron or of other metals having a melting point above that of aluminum, the surfaces of the foils and sheets are separately provided with an extremely fine roughening or matt before being placed together for welding. The consequent annealing of the iron which is necessary when ordinary aluminum sheets are welded to iron plates and then cold-rolled into sheets is thus avoided, and the melting or loosening of the aluminum prevented. The roughening may be produced by cold-rolling of the sheets and foils in separate packs. The iron sheets may also be roughened by brushes or by sand blasting, etching, etc. The sheets and foils are then separately annealed and are then placed together in an airtight manner with roughened surfaces inward. They are then heated to about 600 deg. C. and welded by passing through rolls, the pressure being such as to stretch the foil as much as possible, but to stretch the sheets only slightly. The composite sheets are then heated to 500 deg. C. to anneal the foil. (Br. Pat. 144,706—1919. METALLINDUSTRIE SCHIELE & BRUCHSALER, Baden, Germany, Aug. 11, 1920.)

Hydrogen.—In the iron-steam process of making hydrogen the waste gases of reduction which have been fully spent in passing through a retort or bench of retorts but which still contain reducing gases are treated for the removal of steam and some water vapor, carbon dioxide and sulphur dioxide and other sulphur compounds, and then passed to another retort or bench for effecting reduction of the charge therein; the waste gases may be passed into the furnace setting or discharged into the atmosphere. The process may be carried out with three sets of retorts or benches; while the first set is making hydrogen, the second set is receiving water-gas completely to reduce the charge therein, and the spent gases are treated as above described and passed to the third set; at the next stage, the second set is making hydrogen, the reduction of the charge of the third set is completed by water-gas, and the spent gases are after purification passed to the first set; and so on. To purify the spent gases, they are first passed through a scrubber packed with marble, coke, etc., and down which water trickles and removes the sulphur compounds, then passed through water or potash solution to remove carbon dioxide, and finally through a tubular condenser to remove steam and water vapor; or after passage through the first scrubber, the gases may be passed through a condenser, and afterward through a purifier charged with lime to remove sulphur dioxide. (Br. Pat. 144,751—1919. BRITISH OXYGEN Co., Westminster; S. W. BRAY, Ilford, and I. H. BALFOUR, Buckhurst Hill, Aug. 11, 1920.)

Decolorizing Glycerine.—In processes in which glycerine is recovered from solutions containing sulphuric acid by the addition of barium carbonate and oxalic acid, the glycerine is decolorized by adding the oxalic acid, preferably in the form of powder, before the addition of barium carbonate, and preferably in quantity above that necessary to precipitate the barium salts formed. (Br. Pat. 144,727—1919. ELEKTRO-OSMOSE AKT. GES., Berlin, Aug. 11, 1920.)

Current Events

in the Chemical and Metallurgical Industries

New York Section Meeting, A.C.S.

On Friday evening, Oct. 22, the New York Section of the American Chemical Society was addressed by President W. A. Noyes on "The Foundation for Chemical Development." Dr. Noyes compared the national censuses of chemists, which, at the opening of the war, gave Germany 30,000, the United States 16,000, England 5,000 and France 2,500. One hundred years ago, Liebig went to France to study chemistry under Professor Gay-Lussac. Upon his return to Germany he started the system of university research which led to the subsequent advance of his native land to the front in industrial chemical development.

Dr. Noyes traced the work of Hofmann, and its influence on synthetic dyestuff manufacture after the pioneer work of Perkins. He then took up the thread of American progress and cited the case of Dr. Willis R. Whitney, who taught at Boston Tech on Mondays, Wednesdays and Fridays, did research work for the General Electric Co. at Schenectady on the alternate days and spent his evenings on Pullmans. The efforts of Dr. Whitney have resulted in establishing a research organization ranking among the best in the world. To carry on such work, industries must have men of the highest technical and mental training and to supply these, the universities must have their co-operation.

In the absence of Dr. Harrison E. Howe, Dr. H. A. Bumstead, director of the Sloane Laboratory of Physics at Yale University and chairman of the National Research Council, spoke on the relation of the National Research Council to chemical development. He placed particular emphasis upon the revised tables of physical and chemical constants. From \$150,000 to \$200,000 will be required for the completion of these tables. Substantial amounts have already been pledged by a number of industries. The speaker closed with a reference to the opportunities afforded by the fellowships in physics and chemistry made possible through a fund established by the Rockefeller Foundation.

Meeting of Engineering Council in Chicago

The regular meeting of Engineering Council was held on Oct. 21 in Chicago, with J. Parke Channing in the chair. Resolutions were passed supporting several measures, chief of which were the model license law for engineers, the Nolan Patent Office bill (H.R. 11,984) proposing an increase in the personnel and salaries of the U. S. Patent Office, and the creation of a Department of Public Works.

M. O. Leighton, national service representative, opened the discussion on the bill for a national Department of Public Works by indicating the lack of interest on the part of the many societies and individuals in the promotion of this measure. While the Council was aware of the futility of any sustained support due to its own early termination, it authorized the promulgation of a letter to the societies calling for renewed enthusiasm. A bill of some kind will doubtless

be passed at the next session of Congress, but if the civilian engineers do not act quickly control will rest with the U. S. Corps of Army Engineers.

The model license law was adopted essentially in the form considered by the Council for the past year. It is in form for universal adoption by all states to permit bona fide engineers and architects to operate in any state without the present handicap due to the varying laws now in effect in several.

The names to be suggested to President Wilson as suitable candidates for members of the U. S. Shipping Board are those of Prof. H. E. Riggs, University of Michigan, Ann Arbor, and W. H. Adams, consulting engineer, Detroit, Mich.

The Council authorized support of a measure to secure adequate appropriations for the Federal Power Commission. Decision of the Controller of the Treasury has held the \$100,000 previously appropriated as unavailable. Money is needed especially for research work at the Bureau of Standards.

E. J. Prindle, chairman of the committee handling legislation increasing the number and pay of the Patent Office employees, reported the bill, H.R. 11,984, had passed the House at the last session, but was amended in the Senate committee by Mr. Smoot so as to reduce the force and pay. The Council passed one resolution calling on the Senate for a restoration of the bill to its original status and another calling on engineers for support similar to that originally rendered—i.e., by individual letters acquainting Representatives and Senators with the urgency for passing the measure without revision.

The next meeting of Engineering Council will be held in Washington, D. C., Dec. 16.

Marine Exposition, Chicago

The National Marine Show was held in the Coliseum, Chicago, Oct. 18 to 23. Among other exhibitors were the General Electric Co., the Crane Co., the American Steel Foundries Co., John A. Roebling Sons, Ferguson & Lange Foundry Co., the Valentine Varnish Co., the Lunkenheimer Co., the American Chain Co. and Fairbanks, Morse & Co.

While this exposition does not hold such direct interest as the Chemical Exposition for the men of the profession, nevertheless many manufacturers of chemical plants and from the chemically-controlled industries were interested from the point of view of problems involved in the export business. One of the notable features was a large relief map of the world showing all the trade routes and location of all steamship lines. The purpose of the exposition was to arouse interest in the constantly increasing importance of America's merchant sea power and the relation to its maintenance and national prosperity and the wealth and magnitude of lake and inland water shipping, to the end that this part of the nation's transportation may receive the serious consideration of all branches of industry.

Philadelphia Section Meeting, A.C.S.

The regular monthly meeting of the Philadelphia Section of the American Chemical Society was held Thursday evening, Oct. 21, at the Engineers' Club. The testimonial dinner in honor of Prof. W. A. Noyes, president of the American Chemical Society, was attended by forty members.

In his address, "The Foundation for Chemical Development," Professor Noyes reviewed scientific progress in chemistry in order to show that there is a tendency at the present time to get away from the old spirit of scientific research in the pursuit of more material things. He felt that through careful study and application of the principles underlying the classic researches, American chemists should stand supreme among the chemists of the world.

At the conclusion of Dr. Noyes' address, Dr. Pearson, chairman of the Section, called upon Dr. E. F. Smith, who for so many years was professor of chemistry and provost of the University of Pennsylvania, for discussion. Other speakers called upon were: Dr. H. F. Keller, of the Germantown High School; Prof. W. T. Taggart, newly appointed Blanchard professor of chemistry of the University of Pennsylvania; Dr. Abraham Henwood, of the Drexel Institute; Prof. O. L. Shinn, of the University of Pennsylvania; Prof. E. C. Bertolet, of the Philadelphia Textile School.

New Sugar Plant at Mt. Pleasant, Mich.

The Columbia Sugar Co. is building and expects to have in operation in a short time a 1,000-ton plant, designed by Harry A. Vallez, general superintendent of the company. Steel and concrete construction will be used in the main 255 x 70-ft. building as well as in the warehouses, limekiln, boiler plant and pulp house. The plant will be equipped throughout with electric power. Each unit is designed with an individual motor drive so that any unit can be out at any time without interfering with the operation of the others.

Two 1,000-kw. Allis-Chalmers turbines each capable of running the plant alone will be installed so that one may always be kept as a spare for emergency. Mr. Vallez will install two diffusion batteries of eight cells each of 212 cu.ft. capacity each. A rake type cossette conveyor instead of a belt will feed them. There will be two 11-ft. coil pans, one calandria, and quadruple effect evaporators. Twelve rotary filters, six of which will be used for the first carbonization, three for the second and three for the thick juice filtrate, are to be installed.

The pulp-drying house will be equipped with the Burman improved double-shell drier, with specially designed distributing plates so arranged that when the pulp first enters the drum it is broken up in such a way that none of it is burned. The result is a pulp of unusual whiteness. The furnaces of these driers are equipped with the new Jones Automatic Cleaning Stokers.

Beets will reach the factory in standard-gage railroad cars hauled by a motor-driven car pulley into a rotary car dumper capable of handling any size or type of car up to 60 ft. in length. The dumper clamps the cars, turns them over, empties and rights them in about three minutes.

From the dump the beets fall into a long hopper fitted with duplex feeders so arranged as to carry them to one central point to an inclined conveyor, which

in turn delivers them to the main belt over the storage bins. This belt passes through a tripper device mounted on a traveling bridge and so arranged that the beets are diverted into a reversible shuttle belt also mounted on the bridge. This belt will deliver them to any point on either side of the main belt up to the outer limit of the sheds, a spread of 125 feet.

Meeting of Sub-Committee on Standardization of Petroleum Specifications

An open meeting of the technical sub-committee on Standardization of Petroleum Specifications was held in the auditorium of the Interior Department building, Washington, D. C., Oct. 18, to discuss possible revisions in the Government specifications on gasoline, kerosene, fuel and lubricating oils. The meeting was called to order by Dr. G. W. Gray, chairman of the sub-committee, and the delegates were welcomed by Dr. F. G. Cottrell, Director of the Bureau of Mines, under whose auspices the meeting was held. Representatives of several of the Government departments and petroleum technical societies, a number of state oil inspectors and some of the leading oil refining and marketing companies and automobile manufacturers were present. The petroleum societies were represented by the American Petroleum Institute, National Petroleum Association, Western Oil Refiners Association and the Society of Automotive Engineers.

There proved to be very little criticism of the lubricant specifications, but the refiners were almost unanimous in asking that the 90 per cent point of the gasoline specification be raised a little. The use of the New Saybolt Fuel Oil Viscosimeter was advocated by the refiners, to test the fuel oils used by the Army, the Navy and the Shipping Board, to replace the specific gravity determination required at the present time.

On Oct. 19 the sub-committee met to consider these and other points in connection with the Federal specifications for petroleum products. All the present specifications were taken up at this meeting, including those for gasoline, kerosene, fuel and lubricating oils and greases, which have been published in Bulletins 1, 2, 3 and 4 of the committee, and the possibility of further specifications for other products was also considered. After two days' closed session the sub-committee adjourned on Oct. 20, with the announcement that a report would shortly be prepared for submission to the Presidential committee and that it was probable that this would take the form of a complete and revised code of specifications for all petroleum products which will supersede the four bulletins mentioned above.

Making Films of Industry

Due to the success which has followed the showing of the Bureau of Mines films portraying the development of the coal and oil industries, numerous applications have been received to make pictures of other industries. These films are made under a co-operative agreement by which the industry furnishes the funds and the Bureau of Mines supervises the making of the picture. "The Story of Asbestos" is just being completed. "The Story of Sulphur" is in process of production. Work soon will start on a film showing the best types of insulation and how it may be used to prevent loss of heat.

Improvements at the Factories of the American Window Glass Co.

Although hampered by shortage of labor and supplies, particularly coal, and lack of transportation facilities, the American Window Glass Co., in addition to its specialties, produced 2,636,101 50-ft. boxes of common window glass during the last fiscal year.

In spite of the difficulties encountered during the past this company, with an eye to the future, has made many changes and improvements at its various plants.

In its No. 1 factory at Arnold City, Pa., it was found necessary, in order to take care of its increased output, to build a second story cutting room. As the old batch plant was entirely inadequate, the company has let a contract for a new one which will handle the requirements of the plant with a fraction of the number of men now employed. Arrangements have been made to install conveyors in the No. 2 tank building, which has been shut down for repairs after an operation of three years and ten months. This installation will mean a saving of a large amount of labor in the daily operation of the machines and furnaces. Equipment for use of producer gas is also being installed.

A new tank is being built at the No. 2 factory at Jeanette, Pa., and conveyors for the cellar glass and back ladle skins are being installed. Extension to the cutting room and construction of a number of additional flattening ovens is under way.

Improvements at the No. 2 factory at Hartford City, Ind., consist of a new tank building and furnace which will be an exact duplicate of that at Factory 2.

In Monongahela factory No. 14, a producer plant and power house have been erected and installations of the producer gas flues to the flattening ovens have been made.

Fort Worth Acid Works Plant

The Fort Worth Acid Works, Fort Worth, Tex., is putting into operation a standard recovery plant for sludge acids. This plant is built along the lines of standard design used for a period of years by the Standard Oil Co., and Sinclair Refining and other large oil producers. The large number of successful independent refineries in the territory will supply ample sludge acids for this plant. These refineries have hitherto been experiencing great difficulty and considerable expense with respect to disposition of sludge and welcome the outlet this recovery plant affords.

The unique feature of design of the process consists in using the waste heat from the acid stills through the evaporating pans in place of the old-type direct-fired pans. This effects a large saving in fuel and eliminates one very heavy maintenance expense, since direct-fire pans are notably short-lived and expensive of upkeep. Both the raw and finished material are loaded into tank cars, compressed air being employed throughout the plant.

Failed to Appoint C.W.S. Officers

No authority has been given as yet for the appointment of Corps or Division Gas Warfare officers. A tentative table of the new Army organization does not include the Chemical Warfare Service. There is some speculation as to whether this indicates that the Chemical Warfare Service will have to continue its fight for recognition despite the fact that the Army reorganization act sets it up as a permanent part of the Army.

The Failure of Metals Under Internal or Prolonged Stress

The Faraday Society, Institution of Mechanical Engineers, the Institute of Metals, and probably also the Iron and Steel Institute contemplate holding, early in 1921, a joint general discussion on "The Failure of Metals Under Internal or Prolonged Stress," according to *Engineering* (London). While various aspects of the subject have already been discussed, some new matter will be placed at the disposal of the co-operating societies later in the year, and it is thought that this will afford an opportunity for a more comprehensive consideration of the subject than has yet been given to it. The problem to be discussed is the failure of metal articles as a result either of external stresses to which they have been exposed for any length of time, or of internal stresses arising from conditions of manufacture, such as cold work, unequal expansion or contraction during casting and subsequent operations, including rapid heating and cooling. It is intended that the subject of the discussion should include the phenomena known as "season cracking," "corrosion cracking," "fire cracking" and analogous forms of failure, and that iron and steel as well as non-ferrous metals should be dealt with. The scope of the discussion would permit of contributions relating to the properties and behavior of materials other than metals which might throw light on the phenomena covered by the title.

While invitations have been sent out to certain men to contribute, this by no means is intended to exclude participation on the part of anyone having new information on some aspect of this broad subject. Correspondence along these lines is therefore invited by the secretary of the joint committee, F. S. Spiers, 10, Essex St., London, W. C. 2.

Packing of Dyes, in Powder Form, for Dispatch to Foreign Countries

The following regulations have been issued by the United States Post Office Department regarding the packing of dyes, in powder form, for shipment to foreign countries:

Dyes, in powder form, must not be accepted for transmission in the parcel-post mails to those foreign countries admitting dyes in the parcel-post mails, except the dyes are packed in a tin or metal container and such container inclosed in a substantial outside cover, open to inspection, of fiber board or similar material, double-faced corrugated cardboard, or strapped wooden boxes made of material at least a half inch thick.

The inside tin or metal container must be one closed with a screw-top cover having sufficient screw threads to require at least one and one-half complete turns before the cover will come off, the cover of which must be provided with a washer, so as to prevent possible sifting of the contents.

This provision for the employment of screw-top tin or metal containers does not prevent the use of compression (friction) tin top or metal containers, if soldered in at least four places, or the use of lead-sealed tin or metal containers, provided the containers are labeled in printing so as to show the nature of the contents, the quantity, and the name of the manufacturer or dealer, and, in addition, the containers are inclosed in substantial outside covers, open to inspection, of fiber board or similar material, double-faced corrugated cardboard, or strapped wooden boxes made of material at least a half inch thick.

Acceptable packages of samples of dyes, in powder form, not exceeding 12 oz. in weight, and packed in accordance with the requirements of the Postal Union regulations, will likewise be received for transmission in the international parcel-post service, when postage is paid at the rate of 12c. a lb. or fraction thereof.

British Gray and Malleable Cast Iron Industries Form Research Association

A meeting was held in Birmingham, England, on Sept. 30 in connection with the proposal to form a British Research Association for the gray and malleable cast iron industries. Representatives of the industries concerned gathered from various parts of Great Britain. The chair was taken by M. Riddell, president of the Institution of British Foundrymen. Sir Frank Heath, K.C.B., of the Government Department for Scientific and Industrial Research, gave an address in which he outlined the terms upon which the government would assist the scheme. The main features of the plan are that firms in the industry which join the association shall each guarantee a minimum annual subscription for five years: then, with a definite minimum income guaranteed, the government will assist the association with grants of money pound for pound, but at the end of the 5-yr. period will gradually diminish its contribution as the scheme becomes self-supporting. The government will require certain conditions to be fulfilled, and urged, without making it an absolute condition, that labor should be represented on the council of the association.

Sir Frank described each firm's subscription to the scheme as an insurance premium against the evil effects of ignorance. Dr. Leslie Aitchison (Birmingham) moved and F. J. Cook (Birmingham) seconded a resolution to the effect that "A Research Association for Gray and Malleable Cast Iron be formed." W. R. Barclay (Birmingham) and B. Collitt (Lincoln) spoke in support of the resolution, which was passed unanimously. A provisional council was then elected to proceed with the formation of the association.

During the meeting several of the speakers referred to the success of the researches carried out on behalf of the American Malleable Castings Association, and one of them made a strong plea for the abandonment of the present system of grading pig iron by fracture, and for the adoption of grading by analysis.

Canada Amends Denatured-Alcohol Regulations

A change in the regulations governing the denaturing of alcohol for industrial purposes has been made by the Canadian Government, with a view of making industrial alcohol available to the arts and industries at a more reasonable price than at present. Circulars are being sent out by the Canadian Department of Inland Revenue authorizing the manufacture and sale without restriction of a new grade to be known as Grade 2 benzol. The denaturants used in this are benzol, nitrobenzol, and pine oil, and the cost of these denaturants will be very small as compared with the cost of methanol, which was formerly the only denaturant allowed to be used. The cost of the denaturant, it is stated, is responsible for the high cost of industrial alcohol, and therefore a committee of three members of the Department of Inland Revenue, with two from the research council, held several meetings to decide on the form of a new and cheaper denaturant to be allowed.

While nine distilleries have been licensed for the manufacture of industrial alcohol, it is stated that only two have yet begun the work. The operation of prohibition in Canada had reduced the output of the distilleries to a great extent, and some of these had closed down entirely. As a result, there is a great shortage of alcohol for industrial purposes.

Glasgow to Make Chemicals From Gas Residuals

The Chemical Works Department of Glasgow Corporation, which was instituted about eighteen months ago as an adjunct of its gas department for the purpose of manufacturing chemicals from the gas residuals, will, it is expected, help to reduce the cost of gas to consumers, reports Consul G. E. Chamberlin of Glasgow, Scotland. It was the custom until about a year ago for the corporation to dispose of the residuals to private firms, from which it received a sum for the use of the buildings and equipment and a certain amount for the materials. When the chemical department was formed experiments were carried out which resulted so favorably that the municipality decided to terminate the contracts with the private firms and to undertake the whole of the work itself.

It is proposed to center the refining processes at the Provan works and to carry on crude distillation at the three other gas works and to increase the existing plant considerably. Refining will commence at once. The principal chemicals to be manufactured are motor benzene, pure benzene, toluene, solvent and heavy naphthas, and carbolic acid. The department will also consider the advisability of making dyes and intermediates. From the new installation about 100 tons more of tar will be made per day. The revenue last year from tar and ammoniacal liquor was \$1,491,950, and a conservative estimate places the net revenue from these sources for the current year at \$1,946,600.

Believes Gas Warfare Will Be Developed

Efforts to rule out the use of military gases by treaty are not likely to be successful, in the opinion of General A. A. Fries. Gas warfare gives a very great advantage to the intellectual and more highly developed peoples, General Fries points out. As a nation develops intellectually there is a tendency to lose in brawn. The development of chemical warfare has put in the hands of the more highly developed nations, General Fries says, a weapon which would render them absolutely safe from successful attack from any invader who might happen to have more brawn. Gases, he says, form the ideal weapon of the highly civilized man. "When gunpowder was introduced in warfare, says General Fries, similar protests were made against its use.

General Fries also points out that since the gases used in chemical warfare are also widely used in industries, there could be no agreement to stop their manufacture.

Looking for Chief Chemist for Edgewood Arsenal

Despite intensive efforts on the part of General A. A. Fries, head of the Chemical Warfare Service, to secure a chief chemist to direct the chemical research work at Edgewood Arsenal, his quest has been unsuccessful. Men with the requisite experience receive better salaries and have other advantages which the Government cannot offer. General Fries is hopeful, however, of finding someone who is in a position to make the necessary sacrifice to take the position.

Nitrate of Soda Movement

Of the 148,338 tons of nitrate of soda which moved through the Panama Canal during August all but 46,000 tons was destined to American ports. The remainder went to the European ports.

A Home for the National Academy of Sciences and the National Research Council

A site for the new building in Washington which is to serve as a home for the National Academy of Sciences and the National Research Council has recently been obtained. It comprises the entire block bounded by B and C Sts. and Twenty-first and Twenty-second Sts., N. W., and faces the Lincoln Memorial in Potomac Park. The Academy and Council have been enabled to obtain this site, costing about \$200,000, through the generosity of friends and supporters. Funds for the erection of the building have been provided by the Carnegie Corporation of New York.

Bureau of Mines Succession

Since there is such difference of opinion as to which industry should be represented by the chief of the Bureau of Mines, the suggestion is now made that Dr. F. G. Cottrell, the incumbent, may withhold his proposed resignation and continue in the position of director.

Personal

J. J. ARNEFIELD, advertising manager of Fairbanks, Morse & Co., was elected president of the Engineering Advertisers' Association of Chicago, to fill the vacancy made by the resignation of A. H. Hopkins.

Dr. W. D. BANCROFT, professor of physical chemistry, Cornell University, Ithaca, N. Y., has been engaged by the Norton Co., Worcester, Mass., in a consulting capacity, in connection with its research laboratories.

HOWARD E. BATSFORD is now associated with the newly incorporated American Electric Graphite Mfg. Co., Toronto, Ohio, in the capacity of technical director.

GEORGE GRANGER BROWN is now a member of the staff of the department of chemical engineering, University of Michigan. He was formerly production manager of the Union Special Machine Co.

GEORGE F. DOWNS, president of the Lackawanna Steel Co., Buffalo, N. Y., has been elected a director of the American Iron and Steel Institute, to fill the vacancy caused by the death of Charles H. McCullough, Jr.

ANDREW M. FAIRLIE, sulphuric acid engineer of Atlanta, Ga., has been retained by the Baugh Chemical Co. as consultant in connection with the maintenance and economical operation of its sulphuric acid plants at Baltimore.

WILLIAM A. HAMOR, of the Mellon Institute of Industrial Research of the University of Pittsburgh, has been appointed a member of the National Research Council in the Division of Research Extension.

PAUL E. HOOD has recently taken charge of the experimental department of the Chicago factory of the Marden, Orth & Hastings Corporation.

C. O. JOHNS, who has been for a number of years chief of the color laboratory of the Bureau of Chemistry, has resigned to become director of research of the Standard Oil Co. of New Jersey. Dr. Johns will take up work at his new position about Nov. 15. His work on fundamental problems of the oil industry will probably be conducted at the main plant of the company, near Newark.

R. G. RICH, of the Quigley Furnace Specialties Co., has been appointed assistant manager of the Pittsburgh office, Oliver Bldg.

THEODORE J. SCHAUB has resigned his position as assistant general sales agent of the Crucible Steel Co. of America, to take the position of general sales manager of the Union Electric Steel Co., Carnegie, Pa.

Dr. CHARLES P. STEINMETZ addressed the joint meeting of the American Institute of Electrical Engineers, the Western Society of Engineers and the Chicago Chemists' Club in Chicago, Oct. 20, on the subject "Origin and Energy of the Lightning Flash."

LELAND R. VAN WERT is now with the Harvard Engineering School, Cambridge, Mass., as instructor during the first semester. Two courses in non-ferrous metallurgy will be given.

HILLER ZOBEL has come East from Death Valley, Cal., to engage in industrial chemical engineering research for the Pacific Coast Borax Co., Bayonne, N. J.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Oct. 29, 1920.

The remaking of the iron and steel market is now in full progress. The developments, while apparently mixed in character, are those naturally indicated by the conditions that have preceded. The usual and familiar course of the iron and steel market is being followed except as the peculiar circumstances of the past ten months or thereabout make departures from the normal course natural and necessary.

The chief divergence of the market from a normal course was that prices of the independent steel producers rose far above those maintained by the United States Steel Corporation, and by different amounts at that. Thus there were not simply two markets, there was an indefinite number of markets. If there had been a uniform rise on the part of all producers the liquidation would be uniform. Instead, we have it that nearly all the independent steel producers have curtailed production, while the Steel Corporation's operations continue at the maximum permitted by physical conditions. More than that, there is curtailment common to independents whose position varies. Some, that pursued relatively moderate policies in making prices, have large quantities of business on books, but on account of cancellations and suspensions and postponements of deliveries are unable to predicate a full operation on their order books. These independents are not cutting their prices for the purpose of securing additional business, for to do so would be to jeopardize the contract business they already have. Other independents, with lean order books because they were doing chiefly a prompt business at the particularly high prices prompt deliveries made possible, are cutting their prices, but still do not secure enough orders to operate full, and they curtail production also, though quite differently positioned from the independents first mentioned.

Production of steel at this time is probably about 10 per cent below the rate in August and September, with the curtailment wholly on the part of independents. The Steel Corporation is operating at about 89 per cent of its rated capacity, but its capacity ratings are conservatively low.

EQUALIZATION OF STEEL MARKET PREDICTED BY APRIL

Whether the open market on steel products or that made by the independents will fall rapidly or slowly may depend upon how many independents seek business where it may be found and how many hold aloof, rather depending for operation on their contracts. As to the extent of the decline, the prediction commonly encountered is evasive, since it is that the independent market will decline to the Steel Corporation level, and as to what that level will be in future there is complete uncertainty. Some predict that the corporation will slightly advance its prices, more or less by a horizontal movement, others predict that there will be no material change, while still others predict that the corporation will make a number of reductions, not horizontal, but by way of equalization according to manufacturing costs, the alignment of which, between the various steel com-

modities, has materially altered in the past year and a half. A common prediction is that the market will be equalized, and on a sound basis, by next April, with a buying movement to occur then or by June at the latest.

WEEK'S DEVELOPMENTS

The independent producer which began last week to quote merchant bars at 2.35c., the Steel Corporation price, has withdrawn the quotation, and the bar market appears steady at 3c. to 3.25c., with scarcely any new business being booked.

The softening in strip steel has continued, with 5c. for hot rolled and 8c. for cold rolled the common quotation. Special prices on cold finished steel bars have disappeared, the market being fairly steady at 4.10c.

Sheets have continued to soften, 6.50c. being now a common quotation on black even for prompt shipment, while 8.75c. is exceptional and 9c. common on galvanized, blue annealed being generally on the basis of 5c.

PIG IRON AND COKE

The collapse in pig iron and coke has been phenomenal. Following the general advance in pig iron in August, marked more by the price advances than by the tonnage volume of the buying, there came first a period of no demand, and since then there has come a sharp diminution in demand against contracts. Many consumers have instructed merchant furnaces to decrease the rate of shipping against contract, while some have ordered complete suspension. According to trade practice pig iron contracts are not susceptible of cancellation, as is frequently the case with contracts for finished steel products, but the rate of delivery is much at the option of the consumer.

Following the disappearance of buying of pig iron, prices have shown a tendency to decline on each appearance of an inquiry, while with shipping requirements greatly reduced many furnaces have decided to bank or blow out, and the suspension of shipments of Connellsville coke on the customary "requirement contract" has thrown enough coke on the open market to cause spot prices for furnace coke to toboggan. At this writing the market has declined from \$17 to \$10 in nine business days.

On limited transactions in basic pig iron, chiefly a sale of 1,500 tons by a valley furnace interest to a Pittsburgh district consumer, the quotable market on basic iron has declined from \$42 to \$40 valley furnaces. On an inquiry for 200 tons of foundry iron for Pittsburgh delivery several valley furnaces showed great willingness to quote \$45 furnace, but the business went to another district, at a delivered price still lower than the equivalent of \$45 valley, which would be \$46.96 delivered Pittsburgh. Bessemer pig iron experienced a \$2 decline, to \$45 valley, in still more ignominious manner, since bessemer iron has been offered at \$45 valley without finding any takers at all.

Pig iron and coke are declining, but it cannot be said that they are seeking their level, since in present circumstances no price can be adjudged a proper one. Coke cannot find a legitimate level when there is such an absence of demand, and pig iron cannot find a proper level when the prospective cost of coke is in doubt.

The Chemical and Allied Industrial Markets

New York, Oct. 31, 1920.

One of the most important features of the chemical market is the large amount of supplies accumulating in the hands of dealers who are finding it difficult to convince buyers that the present prices are fair to both parties. The competition brought about by this condition is weakening the market and inquiries for spot material are subject to source and amount desired. On the other hand, there have been no important changes by producers who maintained their prices at recent levels. *Aqua ammonia*, 26 deg., is now available at 9½c. per lb.; the prevailing dullness has affected this item, which until a short time ago was very scarce, and as a result it has fallen off from the former low price of 10½c. per lb. The weakness in *copper sulphate*, crystals, continues with concessions being offered as low as \$7.50 per cwt. in car lots and ranging upward to \$9 in less

car lots. *Sodium cyanide* is one of the few items that has remained firm throughout the present weakness, as the demand for this material has not been influenced to any extent. Producers' prices have remained steady and current quotations of 26@30c. for car lots and 32@35c. per lb. for less car lots still prevail. There is a noticeable weakening in *sodium bisulphate* and the supplies on hand are ample to meet the very low demand; \$7@7.50 per ton is the latest quotation for car lots.

Movement among the *acids* has been downward, as the table below indicates. Buying is exceptionally weak with consequent surplus of supplies.

	DROP IN ACIDS			
	To-day	Last Week	Last Month	Last Year
Citric	60 @ 65c.	70 @ 75c.	78 @ 80c.	85c. @ \$1.00
Oxalic	32 @ 34c.	35 @ 36c.	45 @ 50c.	22 @ 24c.
Phosphoric	19 @ 20c.	20 @ 23c.	22 @ 23c.	10 @ 11c.
Tartaric	60 @ 65c.	70 @ 73c.	75 @ 80c.	\$1.20-1.40

COAL-TAR PRODUCTS

The downward movement in this market has been confined to the intermediates, and even among these it has been slight, as the market is stagnant, with buying at a minimum. In order to attract business concessions are being made on many items. Among these are *aniline oil* and *salts*, the former being listed at 27@30c. and the latter at 33@34c. per lb. *Benzidine base* is also weaker, with current quotations ranging between \$1.25@1.30, which represents a 10c. drop compared with the recent price of \$1.35@1.40 per lb. The *crudes* still maintain the firmness that has been characteristic, although *phenol*, in good supply, is a little easier at a low figure of 11c. per lb.

WAXES

Although buying, as in every other line, has fallen off considerably, the waxes have remained comparatively steady. *Japan* is firm at 18@21c. per lb. and *montan* is a trifle easier at 12@14c. The large supply of *beeswax* on hand has weakened this item considerably and refined dark can be had for 30@32c., while the light is down to 33@36c. per lb.

The Chicago Market

Chicago, Oct. 27, 1920.

Buyers refuse to be tempted even by prices which would have seemed ridiculously low a few months ago. Their offers in most lines are kept at just a little below sellers' asking price, most sales apparently being consummated at a reduction from nominal quotation. By the simple process of buying in meager quantities and that only when the price is satisfactory, the market is being gradually forced down.

In the oil market the combination of cheaper live stock and consequent lower animal oil prices, apparently unlimited crops of flaxseed, corn and peanuts, and the serious curtailment of the textile industry has failed to shake the confidence of some holders of heavy stocks, although current quotations are apparently lower than costs. This feeling of anticipation of a stronger market seems to be based on the belief that stocks in the hands of consumers are unusually low and that a slight increase in industrial activity will promptly act to elevate the entire list.

HEAVY CHEMICALS

Material reduction in the price of *methyl alcohol* has failed to stimulate buying to any great extent and 97 per cent is now quoted at \$2.87 per gal. *Ethyl* grade is practically unchanged at \$5.60@\$5.70 for 190 proof. Old quotations are being maintained nominally on *denatured*, although current transactions are going for about 10c. less, sales being recorded as low as 96c. per gal. Lowered demand and better supply have operated to further weaken *bleaching powder*, a definite price being difficult to name, 6½c. per lb. being probably a fair quotation. *Sal soda* is a little heavy, though the price is unchanged at \$2 per cwt. in reasonable quantities.

Buyer and seller seem deadlocked on *glycerine*, stock being held at about 25c. for dynamite grade, with buyers' offers a cent lower. Actual transactions were negligible

during the period. *Alum* is firm, the market being in producers' hands. *Ammonia lump* is held at 5½¢ per lb. and *potash lump*, though less in demand, is equally firm at 8½¢. *Antimony* is in free supply and is quoted at the low figure of 9¢ per lb. for the powdered needle grade. Acid prices are all weak and supply seems more than adequate for all demands.

COAL-TAR PRODUCTS

Curtailment of operations by textile mills and tanneries has accentuated previous weakness. *Aniline oil* and *aniline salt* are both off another cent, now being obtainable at 26¢ and 33¢ per lb. respectively. *Naphthalene* is changing hands in small quantities only and at prices as low as 10½¢ per lb. for flakes. *Phosgene* is back to normal, 50¢ per lb. ruling on a quiet market.

VEGETABLE OILS

This market is also dormant. Producers of *corn oil*, not caring to come into the market at the prevailing price of 9½¢ per lb. f.o.b. works, are further curtailing operations. Visible stocks are low, but consumers show no anxiety for goods. *Linseed oil* continues to drop, jobbers' barrel price now being \$1.20 per gal. November delivery is offered at 95¢ in tanks and 5¢ less is freely talked. *Red oil*, nominally 10¢ per lb., shows no activity. Bear talk has forced *soya bean oil* down another half cent to 8½¢ in sellers' tanks f.o.b. coast and 17½¢ for local spots. At these prices buyers display small interest.

The St. Louis Market

St. Louis, Mo., Oct. 25, 1920.

After the slight changes reported in the last St. Louis market report the chemical market here seems to have become more stable and practically no changes are to be noted in the last two weeks. While everything is and probably will be quiet for some time, the general tone of the market is healthy.

Buyers here, as well as in other markets, are marking time to some extent, but this fact has not caused any cut in production nor is it likely that it will result in price reductions on a general scale. As a matter of fact the last market report noted several small advances, and these prices are continuing firm. Producers here feel that heavy chemical prices are not too high in consideration of the cost factor and a steady demand. Producers report that contracts are being effected on that basis.

Transportation facilities are better just at present than they have been at any time since the war, there being no difficulty in getting shipments of the raw materials and in shipping out the finished products on schedule time.

Demand for the 66 deg. *sulphuric acid* is steady and prices are holding well. This is a slight improvement over the situation two weeks ago and is the turn of the market that producers had been expecting. There is still evidence that the oil refineries are buying on a basis of present needs. Prices on the 66 deg. acid are \$24 per ton and 1½¢ per lb. in carboys in carload lots. Not much activity is shown in the market for 98 deg. *sulphuric acid* and it is quoted at \$25 per ton, f.o.b. works. The 60 deg. acid holds firm at the advanced price reported two weeks ago of \$16.50 per ton and 1¼¢ per lb. in carboys. *Oleum* also retains the advance noted previously and is in good demand. The price is \$28.50 per ton.

Stocks of *muriatic acid* are still large and demand is a trifle slow. It is quoted at 2@2½¢ per lb. in carboys in carload lots and \$25 per ton in bulk.

The demand for *sodium bisulphate* is steady and there is a large supply in producers' hands. The price is \$5@6 per ton. It is a question whether a quieter steel market may not have some effect on this chemical.

The market for *nitric acid* continues to show strength, but prices remain the same and deliveries are good. The quotations are \$7 per cwt. on the 36 deg. and \$10 per cwt. on the 42 deg. *Standard mixed acid* at 1½¢ per lb. for both the 36 deg. *nitric* and 61 deg. *sulphuric* is holding steady.

Zinc chloride continues to be quoted \$4 per cwt. *Phenol* is quiet at 12¢ in lots of 15 tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.19 - \$0.20	\$0.65 - \$0.75
Acetone.....lb.	3.50 - 3.75	21 - 22
Acid, acetic, 28 per cent.....cwt.	7.50 - 8.00	4.00 - 4.50
Acetic, 56 per cent.....cwt.	14.00 - 16.00	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboys.....cwt.	15 - 16	16.25 - 19
Boric, crystals.....lb.	15 - 16	17 - 20
Boric, powder.....lb.	60 - 65	66 - 70
Citric.....lb.	2.25 - 2.50	2.75 - 3.00
Hydrochloric (nominal).....cwt.	15 - 16	16 - 18
Hydrofluoric, 52 per cent (nominal).....lb.	10 - 11	12 - 16
Lactic, 44 per cent tech.....lb.	0.4 - 0.5	0.6 - 0.7
Lactic, 22 per cent tech.....lb.	4.00 - 4.50	4.50 - 5.00
Molybdic, C. P.....lb.	0.7 - 0.7	0.8 - 0.8
Muriatic, 20 deg. (see hydrochloric).....lb.	0.7 - 0.8	0.8 - 0.9
Nitric, 40 deg.....lb.	0.7 - 0.8	0.8 - 0.9
Nitric, 42 deg.....lb.	32 - 34	35 - 36
Oxalic, crystals.....lb.	19 - 20	21 - 22
Phosphoric, Ortho, 50 per cent solution.....lb.	2.8 - 3.5	2.40 - 2.50
Picric.....lb.	2.30 - 2.55	2.60 - 2.65
Pyrogallol, resublimed.....lb.	12.00 - 16.00	
Sulphuric, 60 deg., tank cars.....ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 60 deg., drums.....ton	26.00 - 28.00	
Sulphuric, 66 deg., tank cars.....ton		
Sulphuric, 66 deg., drums.....ton		
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - 45.00
Tannic, U. S. P.....lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.).....lb.	60 - 70	80 - 90
Tartaric, crystals.....lb.	60 - 65	66 - 70
Tungstic, per lb. of WO.....lb.		1.20 - 1.40
Alcohol, Ethyl (nominal).....gal.	5.50 - 5.75	
Alcohol, Methyl (see methanol).....gal.		1.12 - 1.15
Alcohol, denatured, 188 proof (nominal).....gal.		1.05 - 1.10
Alcohol, denatured, 190 proof (nominal).....gal.		0.51 - 0.6
Alum, ammonia lump.....lb.	0.4 - 0.5	0.51 - 0.6
Alum, potash lump.....lb.	0.7 - 0.8	0.9 - 0.9
Alum, chrome lump.....lb.	14 - 15	16 - 17
Aluminum sulphate, commercial.....lb.	0.2 - 0.3	
Aluminum sulphate, iron free.....lb.	0.2 - 0.3	
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	0.9 - 1.0	11 - 12
Ammonia, anhydrous, cylinders (100-150 lb.).....lb.	35 - 35½	36 - 38
Ammonium carbonate, powder.....lb.	15 - 16	16½ - 17
Ammonium chloride, granular (white salmmoniac) (nominal).....lb.	13 - 14	
Ammonium chloride, granular (gray salmmoniac).....lb.	12 - 13	13½ - 14½
Ammonium nitrate.....lb.	10 - 11	11 - 14
Ammonium sulphate.....lb.	0.7 - 0.7½	0.8 - 0.8½
Amylacetate.....gal.		4.50 - 5.00
Amylacetate tech.....gal.		4.00 - 4.20
Arsenic, oxide, lumps (white arsenic).....lb.	13 - 14	15 - 16
Arsenic, sulphide, powdered (red arsenic).....lb.	16 - 17	18 - 19
Barium chloride.....ton	120.00 - 130.00	
Barium dioxide (peroxide).....lb.	24 - 25	26 - 27
Barium nitrate.....lb.	12 - 12½	13 - 13½
Barium sulphate (precip.) (blanc fixe).....lb.	0.4 - 0.5	0.5 - 0.6
Bleaching powder (see calcium hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.	70 - 80	85 - 90
Bromine.....cwt.	3.50 - 3.55	
Calcium acetate.....cwt.	0.4 - 0.4½	0.4½ - 0.5½
Calcium carbide.....ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, fused, lump.....lb.	0.2 - 0.2½	0.3 - 0.3½
Calcium chloride, granulated.....lb.	7.25 - 7.50	8.00 - 8.50
Calcium hypochlorite (bleaching powder).....cwt.		1.50 - 1.70
Calcium peroxide.....lb.		75 - 80
Calcium phosphate, monobasic.....lb.		25 - 30
Calcium sulphate, pure.....lb.	0.8 - 0.9	10 - 11
Carbon bisulphide.....lb.	13 - 14	16 - 17
Carbon tetrachloride, drums.....lb.		1.25 - 1.50
Carbonyl chloride (phosgene).....lb.		
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.	0.9 - 0.9½	10 - 10½
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	40 - 43	44 - 47
Chloroform.....lb.		2.00 - 2.05
Cobalt oxide.....lb.		
Copperas (see iron sulphate).....lb.	27 - 28	29 - 31
Copper carbonate, green precipitate.....lb.		65 - 70
Copper cyanide.....lb.	0.7 - 0.8	0.8 - 0.9
Copper sulphate, crystals.....lb.		
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.		
Formaldehyde, 40 per cent (nominal).....lb.	40 - 45	5.25 - 6.00
Fusel oil, crude (nominal).....gal.		
Fusel oil, ref. (see sodium sulphate).....gal.		
Glauber's salt (see sodium sulphate).....lb.		26 - 28
Glycerine, C. P. drums extra.....lb.	4.30 - 4.35	4.40 - 4.45
Iodine, resublimed.....lb.		0.3 - 0.4
Iron oxide, red.....lb.	2.60 - 2.25	2.35 - 2.75
Iron sulphate (copperas).....cwt.		13 - 16
Lead acetate, normal.....lb.	11 - 12	13 - 17
Lead arsenate (paste).....lb.		90 - 1.00
Lead nitrate, crystals.....lb.	14 - 15	15 - 16
Litharge.....lb.		1.50 - 1.55
Lithium carbonate.....lb.	12 - 13	14 - 15
Magnesium carbonate, technical.....100 lb.	3.00 - 3.25	
Magnesium sulphate, U. S. P.....100 lb.		3.50 - 3.60
Magnesium sulphate, commercial.....100 lb.		2.70 - 3.00
Methanol, 95%.....gal.		3.40 - 3.60
Methanol, pure.....gal.		14 - 16
Nickel salt, double.....lb.		13 - 14
Nickel salt, single.....lb.		
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	50 - 55	60 - 65
Phosphorus, yellow.....lb.		35 - 37
Potassium bichromate.....lb.	34 - 36	39 - 40

	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar).....	lb. \$0.48 - \$0.56	\$0.57 - \$0.58
Potassium bromide, granular.....	lb. .63 - .65	.63 - .65
Potassium carbonate, U. S. P.....	lb. .50 - .55	.56 - .60
Potassium carbonate, crude.....	lb. .20 - .21	.23 - .25
Potassium chlorate, crystals.....	lb. .18 - .18½	.19 - .20
Potassium hydroxide (caustic potash).....	lb. .23 - .25	.26 - .27
Potassium iodide.....	lb. .30 - .30	3.20 - 3.30
Potassium nitrate.....	lb. .17 - .17½	.19 - .21
Potassium permanganate.....	lb. .63 - .68	.70 - .75
Potassium prussiate, red.....	lb. .85 - .95	1.00 - 1.05
Potassium prussiate, yellow.....	lb. .32 - .36	.35 - .40
Potassium sulphate (powdered).....	ton \$240.00 - 255.00	
Rochelle salts (see sodium potas. tartrate).....		
Salammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake.....	ton 48.00 - 50.00	
Silver cyanide (nominal).....	oz. 1.25	
Silver nitrate (nominal).....	oz. .60 - .62	
Soda ash, light.....	100 lb. 2.25 - 2.50	
Soda ash, dense.....	100 lb. 3.25 - 3.50	
Sodium acetate, U. S. P., granular.....	lb. .25 - .26	.27 - .28
Sodium bicarbonate.....	100 lb. 2.50 - 2.75	2.85 - 3.00
Sodium bichromate.....	lb. .22 - .24	.26 - .27
Sodium bisulphate (nitre cake).....	ton 7.00 - 7.50	8.00 - 11.00
Sodium bisulphite Powdered, U. S. P.....	lb. .06½ - .07½	.08 - .09
Sodium borate (borax).....	lb. .09 - .10	.11 - .12
Sodium carbonate (salt soda).....	100 lb. 2.00 - 2.10	2.15 - 2.25
Sodium chlorate.....	lb. .14 - .15	.15 - .16
Sodium cyanide, 96-98 per cent.....	lb. .25 - .30	.32 - .35
Sodium fluoride.....	lb. .18 - .19	.19 - .20
Sodium hydroxide (caustic soda).....	100 lb. 4.00 - 4.25	
Sodium hyposulphite.....	lb. .03 - .04	
Sodium molybdate.....	lb. 2.50 - 3.25	3.25 - 3.50
Sodium nitrate.....	100 lb. 3.00 - 3.25	
Sodium nitrite.....	lb. .11 - .12	.13 - .14
Sodium peroxide, powder red.....	lb. .32 - .35	.35 - .40
Sodium phosphate, dibasic.....	lb. .03½ - .04½	.04 - .05
Sodium potassium tartrate (Rochelle salts) lb.		.37 - .38
Sodium prussiate, yellow.....	lb. .25 - .27	.31 - .32
Sodium silicate, solution (40 deg.).....	lb. .01½ - .01½	.02 - .02½
Sodium silicate, solution (60 deg.).....	lb. .02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt) cwt.	2.15 - 2.50	2.60 - 2.75
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.09 - .10	.10 - .11
Sodium sulphite, crystals.....	lb. .04 - 0.41	.04 - .05
Strontium nitrate, powdered.....	lb. .15 - .18½	.19 - .20
Sulphur chloride red.....	lb. .08 - .09	.10 - .10½
Sulphur, crude.....	ton 16.00 - 20.00	
Sulphur dioxide, liquid, cylinders.....	lb. .09 - .10	.10 - .12
Sulphur (sublimed), flour.....	100 lb. 3.70 - 4.35	
Sulphur, roll (brimstone).....	100 lb. 3.40 - 3.90	
Tin bichloride, 50 per cent.....	lb. .13½ - .14	
Tin oxide.....	lb. .55 - .60	
Zinc carbonate, precipitate.....	lb. .16 - .18	.19 - .20
Zinc chloride, gran.....	lb. .13 - .13½	.13 - .17
Zinc cyanide.....	lb. .45 - .49	.50 - .60
Zinc dust.....	lb. .12 - .13	.13 - .14
Zinc oxide, U. S. P.....	lb. .17 - .25	
Zinc sulphate.....	lb. .03½ - .03½	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb. \$1.25 - \$1.35
Alpha-naphthol, refined.....	lb. 1.50 - 1.60
Alpha-naphthylamine.....	lb. .45 - .50
Aniline oil, drums extra.....	lb. .27 - .30
Aniline salts.....	lb. .33 - .34
Anthracene, 80% in drums (100 lb.).....	lb. .90 - 1.00
Benzaldehyde (f.f.e.).....	lb. 2.00 - 2.10
Benzidine, base.....	lb. 1.25 - 1.30
Benzidine sulphate.....	lb. 1.05 - 1.15
Benzoic acid, U. S. P.....	lb. .85 - .90
Benzoate of soda, U. S. P.....	lb. .80 - .90
Benzene, pure, water-white, in drums (100 g. l.) gal.	.35 - .40
Benzene, 90% in drums (100 gal.).....	gal. .35 - .38
Benzyl chloride, 95-97%, refined.....	lb. .35 - .40
Benzyl chloride, tech.....	lb. .25 - .35
Beta-naphthol benzoate (nominal).....	lb. 3.50 - 4.00
Beta-naphthol, sublimed (nominal).....	lb. .90 - .95
Beta-naphthol, tech (nominal).....	lb. .60 - .70
Beta-naphthylamine, sublimed.....	lb. 2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.).....	lb. .18 - .19
Ortho-cresol, in drums (100 lb.).....	lb. .23 - .25
Cresylic acid, 97-99%, straw color, in drums gal.	1.10 - 1.15
Cresylic acid, 95-97%, dark, in drums.....	gal. 1.05 - 1.10
Cresylic acid, 50%, first quality, drums.....	gal. .65 - .75
Dichlorobenzene.....	lb. .07 - .10
Diethylaniline.....	lb. 1.50 - 1.60
Dimethylaniline.....	lb. .90 - 1.00
Dinitrobenzene.....	lb. .30 - .37
Dinitrochlorobenzene.....	lb. .32 - .35
Dinitronaphthalene.....	lb. .45 - .55
Dinitrophenol.....	lb. .40 - .45
Dinitrotoluene.....	lb. .38 - .40
Dip oil, 25%, tar acids, car lots, in drums.....	gal. .38 - .40
Diphenylamine (nominal).....	lb. .80 - .85
H-acid (nominal).....	lb. 1.75 - 1.85
Meta-phenylenediamine.....	lb. 1.25 - 1.30
Monochlorobenzene.....	lb. .18 - .20
Monothylaniline.....	lb. 2.00 - 2.40
Naphthalene crushed, in bbls. (250 lb.).....	lb. .12 - .14
Naphthalene, flake.....	lb. .10½ - .11
Naphthalene, balls.....	lb. .12½ - .13
Naphthalonic acid, crude.....	lb. .75 - .85
Nitrobenzene.....	lb. .12 - .15
Nitro-naphthalene.....	lb. .40 - .50
Nitro-toluene.....	lb. .18 - .25
Ortho-amidophenol.....	lb. 3.25 - 4.25
Ortho-dichlorobenzene.....	lb. .15 - .20
Ortho-nitro-phenol.....	lb. .80 - .85
Ortho-nitro-toluene.....	lb. .25 - .40
Ortho-toluidine.....	lb. .35 - .38
Para-amidophenol, base.....	lb. 2.50 - 3.00
Para-amidophenol, HCl.....	lb. 2.50 - 3.00
Para-dichlorobenzene.....	lb. .08 - .10
Paranitraniline.....	lb. 1.10 - 1.15

Para-nitrotoluene.....	lb. 1.25 - 1.40
Para-phenylenediamine.....	lb. 2.50 - 2.65
Para-toluidine.....	lb. 2.00 - 2.25
Phthalic anhydride.....	lb. .60 - .70
Phenol, U. S. P., drums (dest.), (240 lb.).....	lb. .11 - .20
Pyridine.....	gal. 2.00 - 3.50
Resorcinol, technical.....	lb. 4.25 - 4.50
Resorcinol, pure.....	lb. 6.25 - 6.75
Salicylic acid, tech., in bbls. (110 lb.).....	lb. .45 - .50
Salicylic acid, U. S. P.....	lb. .45 - .50
Salol.....	lb. .85 - .95
Solvent naphtha, water-white, in drums, 100 gal. gal.	.30 - .35
Solvent naphtha, crude, heavy, in drums, 100 gal. gal.	.20 - .26
Sulphanilic acid, crude.....	lb. .32 - .35
Tolidine.....	lb. 1.70 - 2.50
Toluidine, mixed.....	lb. .45 - .55
Toluene, in tank cars.....	gal. .35 - .40
Toluene, in drums.....	gal. .38½ - .40
Xylenes, drums, 100 gal.....	lb. .50 - .65
Xylene, pure, in drums.....	gal. .47½ - .50
Xylene, pure, in tank cars.....	gal. .45 - .50
Xylene, commercial, in drums, 100 gal.....	gal. .32½ - .35
Xylene, commercial, in tank cars.....	gal. .30 - .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb. \$0.30 - \$0.37
Beeswax, refined, light.....	lb. .34 - .37
Beeswax, white pure.....	lb. .55 - .67
Carnauba, No. 1 (nominal).....	lb. .90 - .95
Carnauba, No. 2, regular (nominal).....	lb. .75 - .80
Carnauba, No. 3, North Country.....	lb. .25 - .26
Japan.....	lb. .18 - .20
Montan, crude.....	lb. .12 - .14
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb. .09 - .09½
Paraffine waxes, crude, scale 124-126 m.p.....	lb. .09½ - .10
Paraffine waxes, refined, 118-120 m.p.....	lb. .11 - .11½
Paraffine waxes, refined, 125 m.p.....	lb. .12 - .13
Paraffine waxes, refined, 128-130 m.p.....	lb. .13 - .15
Paraffine waxes, refined, 133-135 m.p.....	lb. .16 - .17
Paraffine waxes, refined, 135-137 m.p.....	lb. .17 - .18½
Stearic acid, single pressed.....	lb. .20 - .21
Stearic acid, double pressed.....	lb. .22 - .23
Stearic acid, triple pressed.....	lb. .24 - .25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940.....	gal. \$1.90
Pine oil, pure, dest. dist.....	gal. 1.50
Pine tar oil, ref., sp. gr. 1.025-1.035.....	gal. .48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990.....	gal. .85
Pine tar, ref., thin, sp. gr. 1.080-1.960.....	gal. .36
Turpentine, crude, sp. gr. 0.900-0.970.....	gal. 1.75
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990.....	gal. .35
Pine wood creosote, ref.....	gal. .52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.....	280 lb. \$12.90
Rosin E-I.....	280 lb. 12.90
Rosin K-N.....	280 lb. 12.90
Rosin W-G-W-W.....	280 lb. 12.50
Wood rosin, bbl.....	280 lb. 12.50
Spirits of turpentine.....	gal. 1.12
Wood turpentine, steam dist.....	gal. 1.22
Wood turpentine, dest. dist.....	gal. 1.18
Pine tar pitch, bbl.....	200 lb. 8.50
Tar, kiln burned, bbl. (500 lb.).....	bbl. 14.50 - 15.00
Retort tar, bbl.....	500 lb. 15.00 - 15.50
Rosin oil, first run.....	gal. .72
Rosin oil, second run.....	gal. .75
Rosin oil, third run.....	gal. .92

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal. \$0.40
70-72 deg., steel bbls. (85 lb.).....	gal. .38
68-70 deg., steel bbls. (85 lb.).....	gal. .37
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal. .29

Crude Rubber

Para—Upriver fine.....	lb. \$0.26 - \$0.26½
Upriver coarse.....	lb. .17 - .18
Upriver cauchó ball.....	lb. .17½ - .18½
Plantation—First latex crepe.....	lb. .25 - .25
Ribbed smoked sheets.....	lb. .24 - .24
Brown crepe, thin, clean.....	lb. .22½ - .22½
Amber crepe No. 1.....	lb. .22 - .22

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.....	lb. \$0.16½ - \$0.18
Castor oil, AA, in bbls.....	lb. .15 - .16
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb. .16 - .16½
Cocanut oil, Ceylon grade, in bbls.....	lb. .15½ - .16
Cocanut oil, Cochon grade, in bbls (nominal).....	lb. .17 - .17½
Cora oil, crude, in bbls.....	lb. .12 - .13
Cottonseed oil, crude (f.o.b. mill).....	lb. .10½ - .11
Cottonseed oil, summer yellow.....	lb. .13 - .14
Cottonseed oil, winter yellow.....	lb. .17 - .17
Linseed oil, raw, car lots (domestic).....	gal. 1.07 - 1.07
Linseed oil, raw, tank cars (domestic).....	gal. 1.00 - 1.00
Linseed oil, boiled, car lots (domestic).....	gal. 1.09 - 1.09

Olive oil, commercial.....	gal.	3.00	—	3.50
Palm, Lagos.....	lb.	.10	—	.10
Palm, bright red.....	lb.	—	—	—
Palm, Niger.....	lb.	.09	—	.10
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.10	—	.12
Peanut oil, refined, in bbls.....	lb.	.17	—	.18
Rapeseed oil, refined in bbls.....	gal.	1.30	—	1.45
Rapeseed oil, blown, in bbls.....	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.14	—	.14
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.10	—	.11

FISH

Light pressed Menhaden.....	gal.	\$0.80	—	\$0.90
Yellow bleached Menhaden.....	gal.	.83	—	.87
White bleached Menhaden.....	gal.	.85	—	.87
Blown Menhaden.....	gal.	.90	—	1.00

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	21.00
Barytes, crude, 88% at 94% ba., Kings Creek	net ton	10.00	—	11.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri	net ton	10.00	—	—
Blanc fixe, dry.....	lb.	.05	—	.06
Blanc fixe, pulp.....	net ton	60.00	—	80.00
Casein.....	lb.	.15	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	—	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	—
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	—	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic, lump.....	lb.	.06	—	—
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	—	—	10.00
Quartz (acid tower) 1 1/2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	—	—	—
Shellac, orange superfine.....	lb.	1.05	—	1.10
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Soapstone.....	ton	15.00	—	25.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Talc, California Talcum Powder grade.....	ton	20.00	—	35.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh.....	1,000	—	160
Chrome brick, f.o.b. Eastern shipping points.....	net ton	—	100-110
Chrome cement, 40-45% Cr ₂ O ₃	net ton	—	55-60
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	—	60-65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	—	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	—	45-50
Magnesite brick, 9-in. straight.....	net ton	—	110
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	—	121
Magnesite brick, soaps and splits.....	net ton	—	134
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	—	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	—	50-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	—	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.18	—	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.20	—	.21
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	170.00	—	175.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	170.00	—	175.00
Spiegel iron, 18-22% Mn.....	gross ton	82.50	—	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	60.00	—	65.00
Ferro-silicon, 50%.....	gross ton	80.00	—	90.00
Ferro-silicon, 75%.....	gross ton	150.00	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	.70	—	.80
Ferro-uranium, 35-50% U, per lb. of U content.....	lb.	7.00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6.50	—	8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H ₂ O moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min.....	unit	.70	—	.75
Chrome ore, 50%, max., Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.75	—	.85
*Coke, foundry, f.o.b. ovens.....	net ton	—	—	18.00
*Coke, furnace, f.o.b. ovens.....	net ton	16.50	—	17.00
*Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	24.00	—	—
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	—	—
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	80.00	—	100.00
Ilmenite, 52% TiO ₂ , per b. ore.....	lb.	.01	—	.02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.60	—	.70
Manganese ore, chemical (MnO ₂).....	gross ton	70.00	—	80.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.65	—	.70
Monasite, per unit of ThO ₂	unit	35.00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	—
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport.....	unit	.16	—	—
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport.....	unit	.12	—	.14
Pyrites, domestic, fines.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	—
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃	unit	6.00	—	—
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.50	—	5.00
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	1.25	—	1.50
Zircon, washed, iron free.....	lb.	.05	—	—

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per lb.
Copper, electrolytic.....	15.50
Aluminum, 98 to 99 per cent.....	33.00
Antimony, wholesale lots, Chinese and Japanese.....	7.25
Nickel, ordinary (Ingot).....	45.00
Nickel, electrolytic.....	45.00
Tin, 5-ton lots.....	42.00
Lead, New York, spot.....	8.00
Lead, E. St. Louis, spot.....	7.25
Zinc, spot, New York.....	8.00
Zinc, spot, E. St. Louis.....	7.50@7.70

OTHER METALS

Silver (Commercial).....	oz.	\$0.914
Cadmium.....	lb.	1.40@1.50
Bismuth (500 lb. lots).....	lb.	2.55
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Niagara Falls).....	lb.	1.75
Platinum.....	oz.	95.00@105.00
Iridium.....	oz.	400.00@450.00
Palladium.....	oz.	85.00
Mercury.....	75 lb.	70.00

FINISHED METAL PRODUCTS

Warehouse Price Cents per lb.

Copper sheets, hot rolled.....	25.50
Copper bottoms.....	36.00
Copper rods.....	30.00@35.00
High brass wire and sheets.....	28.50
High brass rods.....	27.00
Low brass wire and sheets.....	31.25
Low brass rods.....	27.00
Brazed brass tubing.....	38.25
Brazed bronze tubing.....	43.00
Seamless copper tubing.....	29.00
Seamless high brass tubing.....	28.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				Cleveland				Chicago			
	Current	One Month Ago	One Year Ago	Current	Current	One Month Ago	One Year Ago	Current	Current	One Month Ago	One Year Ago	Current
Copper, heavy and crucible.....	12.50	17.00	12.00	13.50	12.00	16.00	11.75	12.50	10.00	14.00	10.00	11.00
Copper, heavy and wire.....	12.00	16.00	11.75	12.50	10.00	14.00	10.00	11.00	5.50	4.75	5.50	6.00
Copper, light and bottoms.....	10.00	14.00	10.00	11.00	4.50	3.75	3.75	5.00	7.00	10.50	8.00	12.50
Lead, heavy.....	5.50	4.75	5.50	6.00	4.50	3.75	3.75	5.00	5.50	7.50	5.00	6.50
Lead, tea.....	4.50	3.75	3.75	5.00	7.00	10.50	8.00	12.50	5.50	7.50	5.00	6.50
Brass, heavy.....	7.00	10.50	8.00	12.50	5.50	7.50	5.00	6.50	7.00	10.00	6.00	6.75
Brass, light.....	5.50	7.50	5.00	6.50	4.50	5.00	3.75	5.00	—	—	—	—
No. 1 yellow brass turnings.....	7.00	10.00	6.00	6.75	—	—	—	—	—	—	—	—
Zinc.....	4.50	5.00	3.75	5.00	—	—	—	—	—	—	—	—

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1 in. and larger, and plates 1 in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland			Chicago		
	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago	Current	One Month Ago	One Year Ago
Structural shapes.....	\$4.30	\$4.47	\$3.47	\$3.44	\$3.37	\$4.08	\$3.47	\$3.47	\$3.47
Soft steel bars.....	4.75	4.62	3.37	3.84	3.27	3.98	3.37	3.37	3.37
Soft steel bar shapes.....	4.75	4.62	3.37	3.84	3.27	3.98	3.37	3.37	3.37
Soft steel bands.....	6.43	6.32	4.07	6.25	3.57	4.28	3.67	3.67	3.67
Plat. s. 1 to 1 in. thick.....	4.50	4.67	3.67	3.64	3.57	4.28	3.67	3.67	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

JEWETT CITY—The Fisk Rubber Co., Chicopee Falls, Mass., plans to build a large rubber plant. E. Allen, 52 Vanderbilt Ave., New York City, engr.

Illinois

CHICAGO—The Sanitary Dist. of Chicago, 910 South Michigan Ave., has awarded the contract for the construction of the Calumet sewage treatment plant, to T. J. Forschner Contg. Co., 125th and Michigan Ave., \$4,900,527.

KEWANEE—The city is having plans prepared for the installation of intercepting sewers, tanks and sprinkling filters. Estimated cost, \$250,000. Alvord & Burdick, 8 South Dearborn St., Chicago, engr. Noted May 12.

Kansas

NEWTON—Bethel College is having plans prepared for the construction of two 3-story, 85x150-ft. buildings, including a science hall, etc. Estimated cost \$400,000. Lorentz Selnick & Co., 121 North Market St., Wichita, archts.

Maryland

BALTIMORE—The Church House and Infirmary, Bway, and Fairmont Ave., plans to build a 6-story addition to the hospital. A chemical laboratory will be installed in same. Estimated cost, \$600,000. Wyatt & Nolting, 1012 Keyser Bldg., archts.

Michigan

TRENTON—The city engaged C. W. Hubble, engr., 2348 Penobscot Bldg., Detroit, to prepare plans and submit estimates for the construction of water main extensions and filtration plant. The plans include the construction of a filter bed, etc.

Minnesota

DULUTH—J. T. McNicholas, Bishop, has awarded the contract for the construction of a 2-story, 150x150-ft. school on 28th Ave. East, and 5th St., to McLeod & Smith, Sellwood Bldg., at \$396,300. Chemical laboratory equipment will be installed in same.

RENVILLE—A. R. Hollenberg, clk of the Bd. Educ., will receive bids until Dec. 1 for the construction of a 2-story, 90x240-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$300,000. Croft & Boerner, Lonsdale Bldg., Duluth, archts and engr.

ST. PAUL—The Diocese of St. Paul is conducting a campaign to raise \$5,000,000 for schools and colleges. The building plans include the construction of a science hall, etc., at the college of St. Thomas, Mernan Park.

New Jersey

METUCHEN—D. Wortman, archt. and engr., 116 Lexington Ave., New York City, will receive bids until Dec. 1 for the construction of a 1- and 2-story addition to the factory for the General Ceramics Co., 50 Church St., New York City. Estimated cost, \$400,000.

New York

REDFORD HILLS—L. F. Pilcher, State Arht., Capitol, Albany, has awarded the contract for the construction of a filtration plant at the New York State Reformatory here, to M. J. Launder, 199 South Lexington Ave., White Plains. Estimated cost, \$6,500.

BUFFALO—The Angola Tire & Rubber Co., 270 North Division St., has awarded the contract for the construction of a 2-story, 50x96x126-ft. addition to its factory, to J. A. Zoll, 398 Bird Ave. Estimated cost, \$55,000.

North Carolina

GREENSBORO—The Armour Fertilizer Co. has awarded the contract for the construction of a 1-story, 80x180-ft. fertilizer

and storage building, to the Austin Co., Bulletin Bldg., Philadelphia. Estimated cost, \$150,000.

Ohio

CLEVELAND—The Cleveland Steel Barrel Co., 9619 Meech Ave., has awarded the contract for the construction of a 1-story, 60x120-ft. factory at 9700 Meech Ave., to R. Hansen, 9723 Sandusky Ave. Estimated cost, \$25,000.

MIAMISBURG—The Bd. Educ. will soon award the contract for the construction of a 2-story, 84x92-ft. grade school. Estimated cost, \$125,000. F. L. Packers, New Hayden Bldg., Columbus, archt.

WEST PARK—The Bd. Educ. plans to build a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$1,000,000. F. W. Featherstone, clk.

Oklahoma

TULSA—The city is having preliminary plans prepared for the construction of 6 additional filter units etc. Estimated cost, \$350,000. Halway Eng. Co., 230 Lynch Block, engr.

WAYNOKA—The city plans an election in November to vote on \$60,000 bonds for the construction of a sewage disposal plant. H. S. Olmsted & Co., 417 Exch. Bldg., Oklahoma City, engr.

Pennsylvania

HATBORO—The Roberts and Mandor Stove Co., 11th and Washington Sts., Philadelphia, has awarded the contract for the construction of a 1-story, 60x100-ft. addition to its foundry, to the Austin Co., Bulletin Bldg., Philadelphia.

PHILADELPHIA—The General Carbonic Co., 847 North 3rd St., has awarded the contract for altering the 1-story factory and boiler house, to the Austin Co., Bulletin Bldg. Estimated cost, \$10,000.

PHILADELPHIA—The Philadelphia Dyeing & Finishing Co., Frankford and Vandike Sts., is having plans prepared for the construction of a factory on Torresdale St. Chemical equipment for the manufacture of dyes will be installed in same. Estimated cost \$50,000. M. Ward Easby, Crozer Bldg., archt.

UNIONVILLE—The Consolidated Bd. Educ., East and West Marlboro, Newlin and Pocompsin, is having preliminary plans prepared for the construction of a 2-story vocational school here. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Ritter & Shay, North Amer. Bldg., Philadelphia, archts. and engr.

Virginia

QUANTICO—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to build an incinerator plant to include a septic tank, etc., at the marine barracks, here.

West Virginia

BLUEFIELD—The Baptist Educ. Comm. plans to build 18 buildings, including a science hall, etc. Estimated cost, \$750,000.

Wisconsin

FOND DU LAC—The Fond du Lac Paper Co., c/o Morris Green, 298 Forest Ave., plans to build a 1- and 2-story, 100x300-ft. paper board factory on the shore of Lake Winnebago. Estimated cost, \$100,000.

MAYVILLE—The Free High School Dist. plans to construct a 60x280 ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$200,000.

MILWAUKEE—The Red Star Yeast Co., 27th and St. Paul Aves., has awarded the contract for the construction of a 2-story, 50x95-ft. yeast manufacturing building, to E. Steigerwald & Co., 3607 Vliet St. Estimated cost, \$30,000.

PLYMOUTH—The Plymouth Fdry. & Machine Co., has awarded the contract for the construction of a 1-story, 150x162-ft. foundry and machine shop on Stafford St., to M. Runge, Main St. Estimated cost, \$100,000.

SHEBOYGAN—The Vollrath Co., 13th and Michigan Aves., has awarded the contract for the construction of a 1-story, 180x200-ft. stamping shop for an enamel-ware manufacturing plant on Michigan Ave., to the D. P. Robinson Co., 61 Bway., New York City. Estimated cost, \$100,000.

WAUWATOSA—The Aromatic Chemical Co., 61st and Motor Ave., plans to rebuild its 2-story, 60x100-ft. chemical factory on Motor Ave., which was recently destroyed by fire.

WAUWATOSA—The city has awarded the contract for remodeling the sewage disposal plant, to the Kroening Constr. Co., Majestic Bldg., Milwaukee. Estimated cost, \$27,252.

Ontario

LONDON—The city plans to develop the sulphur well by constructing a plant for purifying the water and removing the sulphur. Estimated cost, \$30,000. H. V. Buchanan, Pub. Utilities Bd., London, engr.

MIDLAND—The city has appointed E. A. James & Co., engr., 36 Toronto St., Toronto to prepare plans for sewer extensions. A sewage disposal plant will probably be installed. Estimated cost, \$100,000.

NIAGARA FALLS—The Oneida Community Co. has awarded the contract for the construction of a 1- and 2-story manufacturing building, to Bancroft Jones Co. and for finishing and heat treating buildings to Norman McLeod, Kent Bldg., Toronto. Estimated cost, \$200,000.

SMOOTH ROCK FALLS—The Matagami Pulp & Paper Co. has awarded the general contract for the construction of a 2-story pulp mill and store buildings, to Carter, Halls Aldinger Co., Union Bank Bldg., Winnipeg. Estimated cost, \$490,000.

ST. CATHERINES—The Bd. Educ. plans to build a 3-story collegiate institute. A physical and chemical laboratory including equipment will be installed in same. Estimated cost, \$400,000.

TORONTO—The Dominion Envelope & Carton Co., 150 Duchess St., has purchased a 7-acre site at Eastern Gap and plans to build a 1-story, 300x500-ft. envelope and paper box factory on same. Estimated cost, \$500,000.

TORONTO—The Northern Aluminum Co., Sterling Rd., plans to build a plate mill here. Estimated cost, \$200,000. B. H. Prack, 50 Bay St., engr.

Industrial Notes

BLAW-KNOX Co., Pittsburgh, Pa., had an exhibit at the American Foundrymen's Association exhibition, held at Columbus, O., Oct. 4 to 8, consisting of clamshell buckets, water cooled furnace appliances and Prudential steel buildings.

THE H. H. ROBERTSON Co., Pittsburgh, Pa., announces the election of C. D. Mercer as vice-president in charge of sales. This occurred at the completion of Mr. Mercer's first year as sales manager of the company. W. S. Tallmann has been elected in charge of operation from Sept. 1. Mr. Tallmann will have charge of all factories, the tin reclamation, the traffic and purchasing departments. D. W. Jasper was appointed manager of the purchasing department, vice W. E. Coe, who resigned to go into the railway supply business with the Beck Hill Corp., New York City. Mr. Jasper joined the company June 1 and has been temporarily connected with the Pittsburgh district sales office.

FREYN, BRASSERT & Co., engineers, Chicago, Ill., have been appointed consulting engineers for the Royal Netherlands Blast Furnace and Steel Works Co., The Hague, and plans and purchases are under way for the construction of two blast furnaces at IJmuiden, Holland. The plant is planned along American lines throughout, inclusive of furnaces, hot blast stoves, gas washing, ferro-concrete bins, charging, blowing and other equipment. The plant will be the first application of American practice in furnace lines, filling, blowing and general operation with Continental ores and cokes.

DYESTUFFS & CHEMICALS, INC., of St. Louis, Mo., has recently been organized and incorporated with a capital stock of \$10,000 to engage in the manufacture of dyestuffs and chemicals. Further information may be had from Joseph F. Kelly, 3023 Allen St., St. Louis, Mo.

THE MONSANTO CHEMICAL WORKS, ST. LOUIS, MO., has opened a Chicago office where a complete stock of the company's products is to be carried. W. L. Filmer, previously in charge of a division of the company's St. Louis sales department, will be in charge.

PIERCE & SKOGMARK, INC., metallurgical and chemical engineers, formerly at 35 Nassau St., New York City, announce that they are now in the practice of engineering work with L. L. Summers & Co., 140 Nassau St., New York.

THE FREDERICK ENGINEERING CO. has opened up a district sales office at 1247 Marquette Bldg., Chicago, under the management of Fred W. Gillette, who will have charge of the distribution of automatic stokers and steam jet ash conveyors in this territory.

THE ST. LOUIS CHAMBER OF COMMERCE, PRODUCTION BUREAU, is collaborating with Louis C. Chapman, consulting geologist, in the preparation of a report and survey of the minerals produced commercially in Missouri. The aim of the survey is to establish definite knowledge of the state's mineral resources.

AMERICAN ELECTRIC GRAPHITE MFG. CO., Toronto, O., has recently been incorporated with a capital stock of \$175,000. Victor M. Weaver is president and general manager, Alfred Whiteside secretary and treasurer and Howard E. Batsford technical director. The company has a factory two miles south of Toronto, O., at the site of the Calumet Sewer Pipe Co. It has 115 acres of coal land, with mining rights.

THE CHEMICAL EQUIPMENT CO., Chicago, Ill., has discontinued its Philadelphia agency, which was under control of Edward M. J. Figel, and in order to better serve its customers has appointed the Filtration Engineers, Inc., 253 Broadway, New York, as New York district agents, and C. A. Murphey, Hurt Bldg., Atlanta, Ga., as Atlanta district agent.

THE AMERICAN STEAM CONVEYOR CORP., Chicago, Ill., announces a change in name, to the Conveyor Corporation of America. Clarence C. Brinley has been retained as Eastern manager of the trolley carrier dept. and will be attached to the New York office, 110 West 40th St. Mr. Brinley was formerly with Gifford-Wood Co. and during the war was conveyor engineer for the Air Nitrates Corp.

THE FREEPORT CHEMICAL CO. plant, at Freeport, Tex., has been acquired by the Stauffer Chemical Co., San Francisco. General headquarters for the plant, under the new ownership, will be located in Houston. R. E. Demmon, of San Francisco, will be local manager. Refined sulphur in various forms is manufactured. The Freeport Chemical Co. is a separate organization from the Freeport Sulphur Co.

DANIEL M. LUEHR, industrial consulting engineer, announces the removal of his offices to 2015 East 65th St., Cleveland, O.

THE NATIONAL LIME ASSOCIATION announces the appointment of Major E. Holmes as manager of the chemistry department. Dr. Holmes is a graduate of Indiana University and a post-graduate of Cornell. His industrial experience has been broad and has included the technical control of factory products, development of new products, building and operation of plants, consulting work with department heads, and the direction of industrial research. Dr. Holmes' services are available to everyone interested in the chemical uses of lime.

C. W. HUNT ENGINEERING CORP. has been formed with offices at 143 Liberty St., New York City, for the purpose of handling all sales entailing engineering in connection with the Hunt products and all engineering services previously performed by C. W. Hunt Co., Inc.

THE AMERICAN ENGINEERING CO., Philadelphia, Pa., has opened a new office in Cincinnati, for the purpose of extending Taylor stoker representation and service. M. M. Masson is in charge of the office, at 207 Neave Bldg.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., announces the successful starting up of new Greaves-Etchells electric furnaces at the Vancouver Engineering Works, Vancouver, B. C., and the Sullivan Machinery Co., Claremont, N. H.

Manufacturers' Catalogs

THE EAGLE-PICHER LEAD CO., Chicago, Ill., has issued a booklet on Eagle-Picher Products.

THE JEFFREY MFG. CO., Columbus, O., calls attention to an attractive 128-page catalog, No. 267, on Jeffrey Machinery for Every Industry, issued by the Export Division. In the foreword it says: "The great saving in time and labor effected by the mechanical handling of materials in nearly every industry of the world, as illustrated in this

book, is proof that labor-saving machinery is of invaluable service in this day of modern method." Many photographs are given which have been selected for the purpose of making it possible to draw a parallel to similar operating conditions, while the tables of sizes have been given to make more comprehensive the magnitude of equipments shown.

THE GENERAL ELECTRIC CO., Schenectady, N. Y., is issuing Bull. 48704A, which supersedes Bull. 48704. This bulletin, on Insulating Compounds, presents the principal characteristics and effective adaptations of the wide field of insulating and coating materials in a practical manner. It gives the imperative factors in selection as well as data on black and clear baking and air-drying varnishes; baking and air-drying japans; double-boiled linseed insulating oils; stickers and shellacs; pothead, joint, coil filling, metal filling, impregnating and various sealing compounds; air-chute cement; priming and finishing paints, enamels, lacquers, etc. These several compounds include every form of coating, impregnating, bonding, filling and finishing all parts of electric apparatus and accessories, such as motor, transformer, and regulator coil-windings, armatures, compensators, commutator rings, contactor connections, bushings for switches, etc., for waterproofing, insulating, rust prevention and durability. General information is also given on the application of compounds, on baking ovens, thinners, containers, etc.

THE MERRILL CO., San Francisco, Cal., has recently issued an attractive booklet on the Merco Nordstrom Valve, explaining why "It Can't Stick, It Won't Leak, It's Always Lubricated." Copies of the catalog may be obtained from the eastern office of the company in the Monadnock Bldg., in Chicago.

THE A. H. SLOAN CO., INC., Detroit, Mich., has issued Bull. 5-B, on Royer Flow Indicators. These are adaptable to measurement of steam, air, gases, water and a number of cases involving the measurement of chemicals, such as bicarbonate of soda solution, saponified oils, cutting compounds, ammonia liquors, etc. The instrument was originally developed to control the lubricating oils in the main bearings of the turbine power plant installed in the Eagle patrol boat manufactured for the Government, and has since been adapted to chemical work. The construction of all types of meters is based on the Pitot tube principle. By means of tabulated data and graph charts the readings taken by the operator are materially simplified. In measuring corrosive liquids an oil seal is sometimes provided to prevent the solution being measured from coming in actual contact with the steel parts, and the parts which in this case are impossible to protect are made from monel metal or other alloy, depending on the chemical reaction encountered. Type C-200 and E-300 are especially adapted for conditions where the point of measurement is isolated from the point at which the actual reading is to be taken. The portable outfit Type T-200 is an evolution of the stationary type, with means for adjusting the impact tube, when it becomes necessary to make a search or traverse from the point of average velocity in the line, also micrometer adjustment for slope to magnify the deflection in the manometer for velocities which are too low to produce a readable deflection in a vertical manometer.

HOLZ & CO., New York City, announces new bulletins on new and improved testing apparatus: Bull. 9, Amsler Standardizing Boxes, for checking tensile and compressive loads of testing machines; Bull. 10, the Humphrey Static Notched-Bar Testing Machine, for the quantitative measurement of the brittleness and ductility of steel and other metals, yielding autographic record of the bending-angle bending-moment diagram; with automatic integrator for total energy absorbed in breaking the test piece; Bull. 11, the Eden-Foster Repeated Impact Testing Machine, for investigating the resistance of metals to fatigue produced by repeated stresses of low force; Bull. 41, Apparatus for Magnetic Analysis, designed by Dr. C. W. Burrows; the rail defectoscope, rod analyzer, wire analyzer and cable defectoscope.

BASTIAN-BLESSING CO., Chicago, Ill., has just received from the press its new catalog on "Rego Welding and Cutting Apparatus." Various details of torches and regulators will be found in this booklet, together with prices of complete equipment and accessories.

ARMSTRONG CORK CO., Pittsburgh, Pa., has issued a new publication, "Nonpareil Insulating Brick," a 72-page book on the insulation of high temperature industrial equipment, such as boilers, furnaces, stills, hot blast stoves, ovens, kilns, etc. While

dealing particularly with the description of Nonpareil brick and their uses the book is more than a catalog. The subject of heat insulation has been thoroughly studied from both the theoretical and practical standpoints, and the results here compiled contribute to make this book a really valuable and instructive treatise. It is conveniently divided into sections, each dealing with a particular type of industrial apparatus so that any one can readily find the data for the equipment in which he is especially interested. Operating records, with and without insulation, are given, actual dollars-and-cents savings demonstrated, and the economy and advantages to be secured by the use of Nonpareil brick described in a most interesting and convincing manner. The book is attractively and substantially bound and profusely illustrated. Its subject matter is of such vital importance to all industries employing high-temperature equipment that plant managers, superintendents and engineers will find it a valuable addition to the technical library.

THE CONNERSVILLE BLOWER CO., Connerville, Ind., has just issued a revised bulletin, No. 110, describing the Victor blowers which are being used in connection with heat-treating and annealing furnaces, forges and other installations where air is desired in small quantities and under medium pressures.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting on employment and education in the Congress Hotel, Chicago, on Nov. 12.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN GAS ASSOCIATION will hold its second annual convention at the Hotel Pennsylvania, New York, Nov. 15 to 20.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

PHILADELPHIA SECTION, AMERICAN CHEMICAL SOCIETY, will hold its regular meeting Nov. 18 at the Engineers' Club, Philadelphia. Ellwood Hendrick will speak on "Relativity and Life."

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Nov. 5, Society of Chemical Industry; Nov. 19, American Chemical Society; Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry, and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.